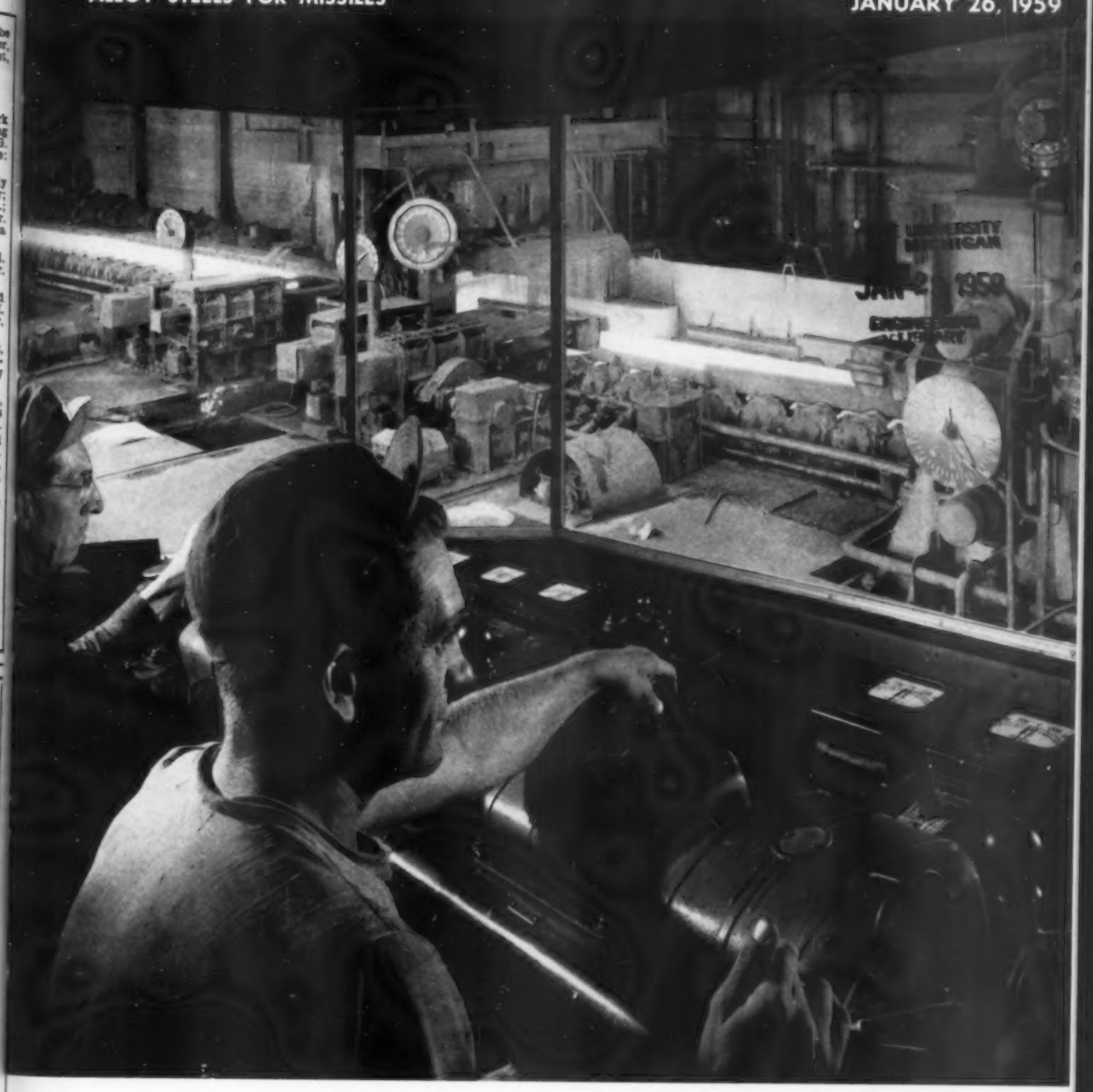
ALLOY STEELS FOR MISSILES

JANUARY 26, 1959



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

FY 1960 Space-Missiles Budget . . . 22

Outlook for Missile Materials 24

Infrared for Re-entry 29

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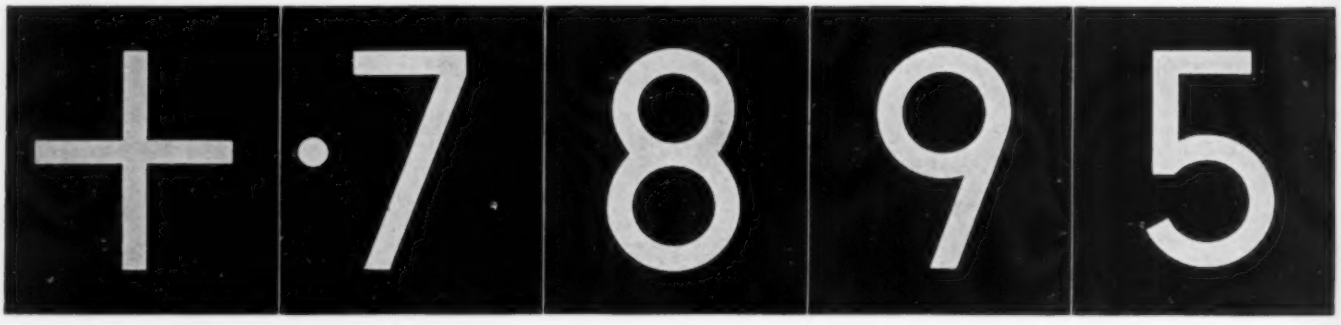

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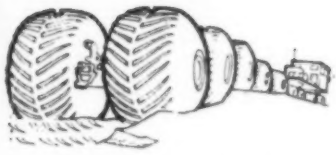

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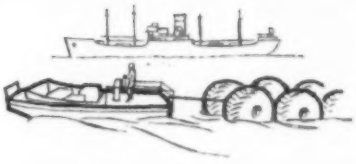

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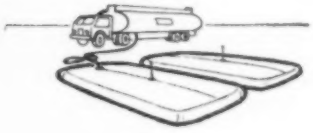

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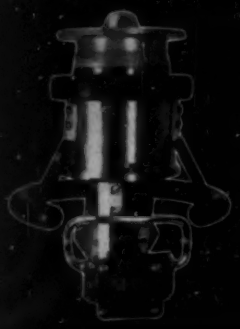

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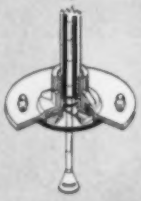

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Cover: Acme-Newport Steel Co. Reduces ingot to plate for astronautics work. (p. 24)

JANUARY 26 HEADLINES

$7 Billion for Missiles; $830 Million for Space

President sends $77 billion budget to Congress; *Minuteman, Hound Dog, Polaris* programs to benefit; ARPA and NASA budgets increased 21

ASTRONAUTICS ENGINEERING

1959 Missile Materials Outlook

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SPARROW III IN ACTION . . .

Rapid fire sequence shows second generation air-to-air missile in action.

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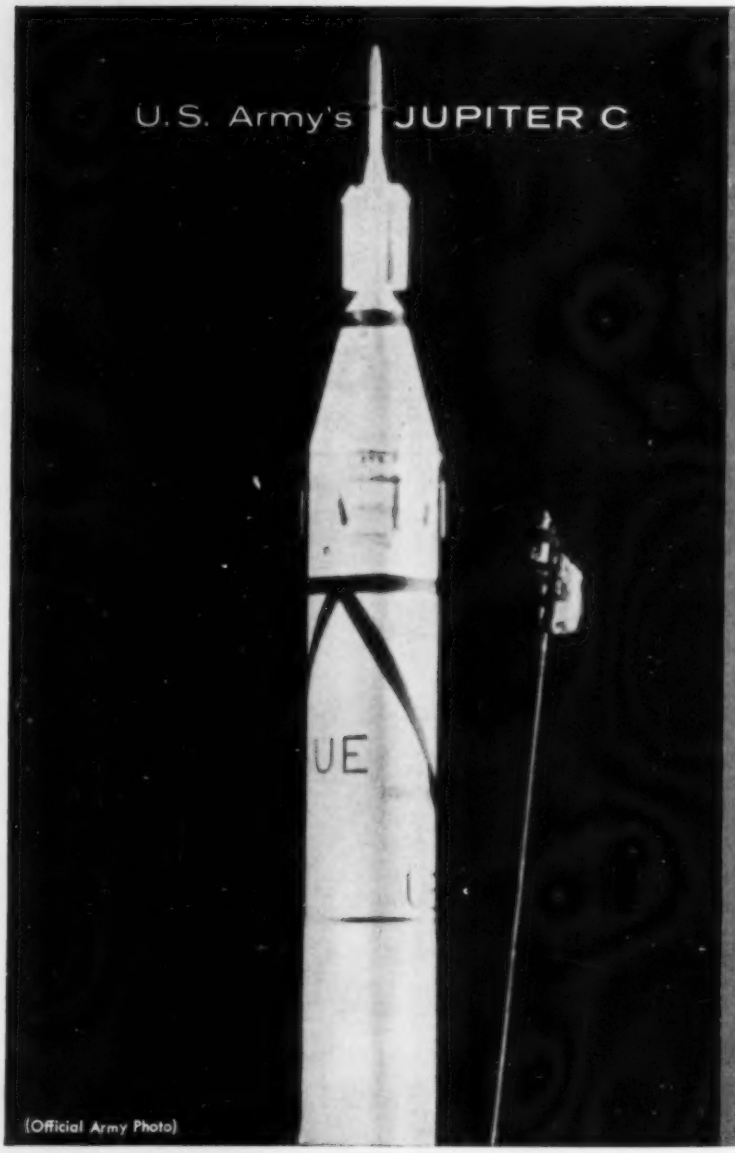

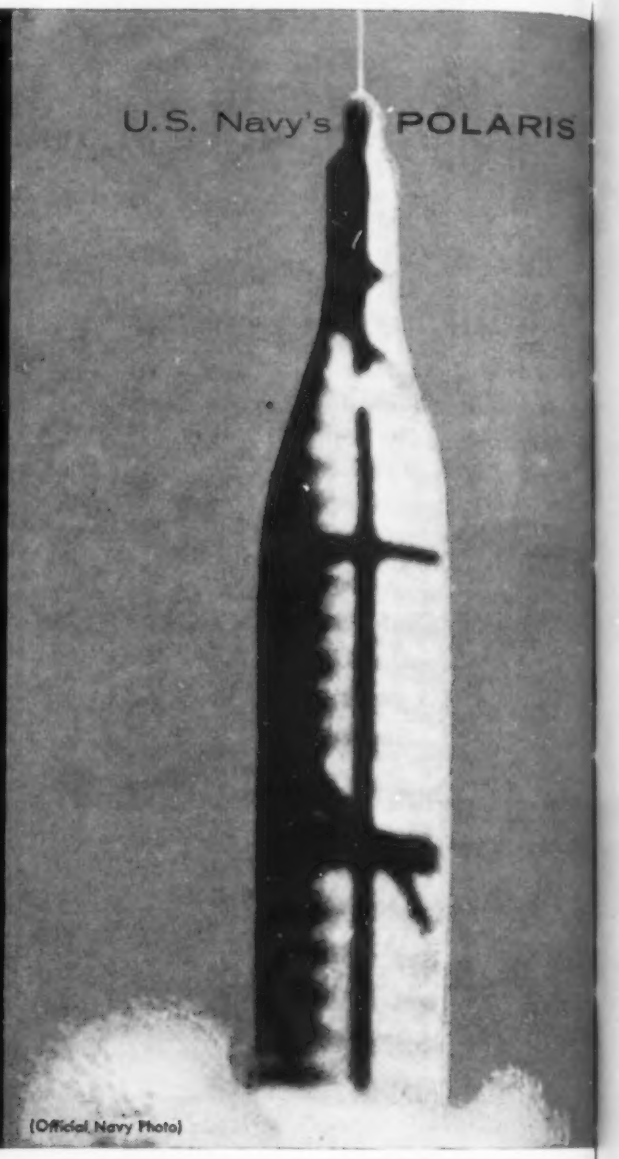

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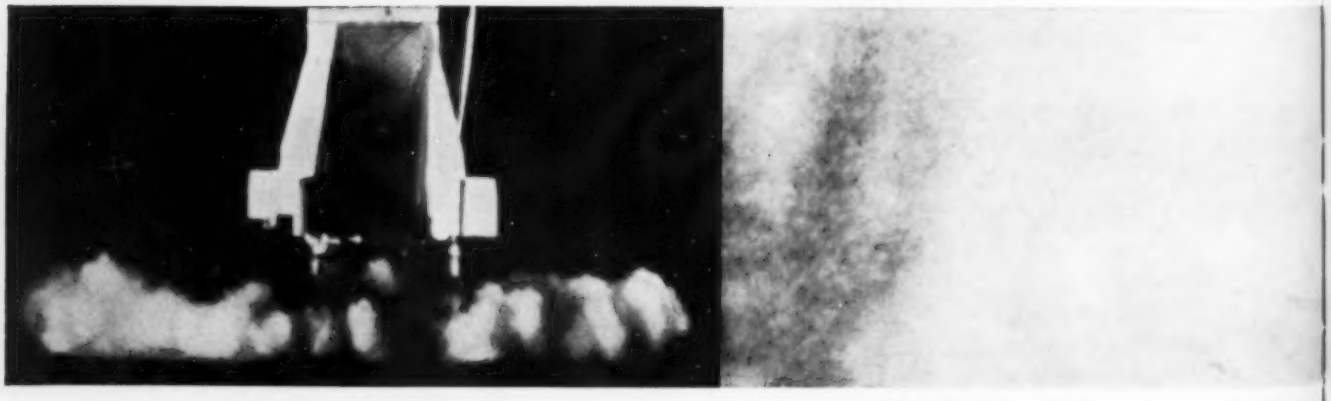

Neither Life nor Defense Ends at 40

There are any number of questionable things in the President's proposed federal budget for Fiscal Year 1960 (like basing its balance on some highly dubious proposed legislation) but m/r's chief quarrel is with the way it plays fast and loose in a numbers racket with the security of the country.

The President and the administration seem to be preoccupied with the number "forty." Is it magic? For three years—1958, 1959 and now 1960—the budget of the Department of Defense, which includes the services, the Advanced Research Projects Agency and the Office of the Secretary of Defense itself, has been arbitrarily pegged at $40 billion, plus or minus about the cost of one missile launching.

Comes *Sputnik*, comes *Lunik*, comes hell or high water, the security of the United States of America seems to be rated at $40 billion. There isn't even an increase for the rising cost of living, let alone the cost of a million-pound-thrust engine or a multi-ton satellite which would help us gain parity with the Russians in the space race.

Instead of an adult acceptance of the country's situation and an honest approach to solution, we are given figures, previously arrived at, which don't mean exactly what they say. (And, incidentally, don't say it the same way twice throughout the 1027 pages of the budget book—What a spot for some R&D on standardization.)

We are informed, for instance, that the budget includes some $5½ billion for military research and development—a healthy increase over the previous two years—and then shyly told that this sum includes test and evaluation support. This is another way of saying that the money for the very expensive test hardware and test activities—such as range operation—now comes from R&D funds instead of from production and procurement as it had before.

We are told that the budget for Fiscal 1960 includes about $7 billion for missiles—and then comes the admission that this really means missile systems and that includes about everything except the blockhouse sink. It takes in, for example, the cost of the *Polaris* submarine being constructed to fire the *Polaris* missile. It takes in the cost of constructing *Titan* bases—right down to the cement hardstands —at Cheyenne. This may be all right and proper but why not say so plainly? How much are we going to spend for actual missiles which would give us some measure of our defense situation?

Nestling in the budgets for the National Aeronautics and Space Administration and the Advanced Research Projects Agency is something on the order of $700 million to be spent during Fiscal 1960 on space projects, both peaceful and military. This figure must encompass research, development and testing of every space project accomplished during 12 months. It must cover such items as the *Discoverer* program, under ARPA, which envisions a dozen or so satellites in orbit, possibly ending with a reconnaissance camera.

It must cover NASA's Project *Mercury*, which hopes to place mice, monkeys and men in a space capsule to orbit the earth and be recovered. It must cover a million-pound-thrust engine in one piece (NASA) and a million-and-a-half-pound-thrust engine clustered (ARPA). Elsewhere in this issue are more detailed listings of the roles and missions of these two agencies on whose talents (and budgets) rest the future security of the country, from a space point of view.

And it's business as usual for the nuclear-powered airplane and its capability as a missile launching platform. About the same amount will be spent on this project in 1960 as in 1959, the President said. This, incidentally, was darned little.

Rep. George Mahon, chairman of the House Defense Appropriations Subcommittee, should find a great deal of support for his attitude after reading the budget. He said:

"There is every likelihood that the 1960 defense budget will be found wanting. The American people are willing to pay for adequate defense. And I propose to put the defense program ahead of budgetary considerations."

We believe the people of this country would prefer to face up to, deal with and pay for an honest and forthright defense program, rather than be fooled by figures which add up to a magic number.

Clarke Newlon

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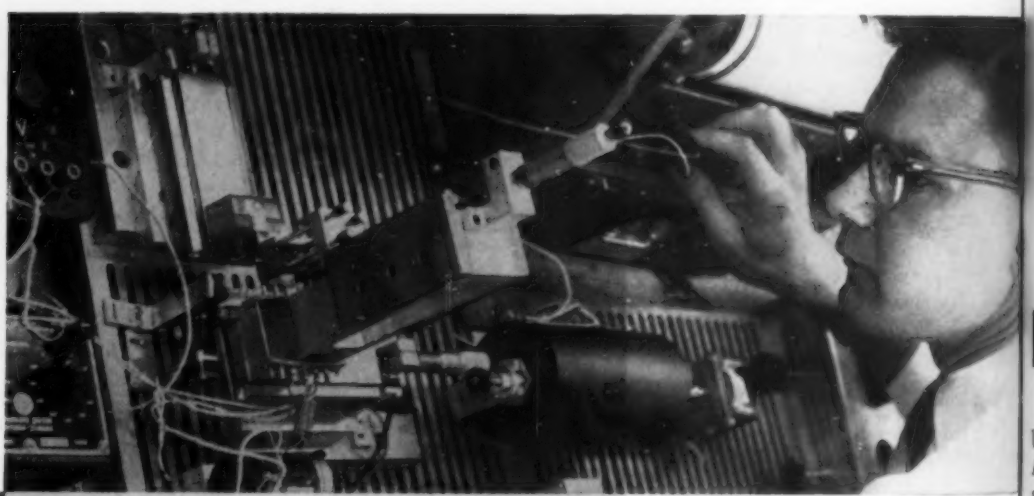

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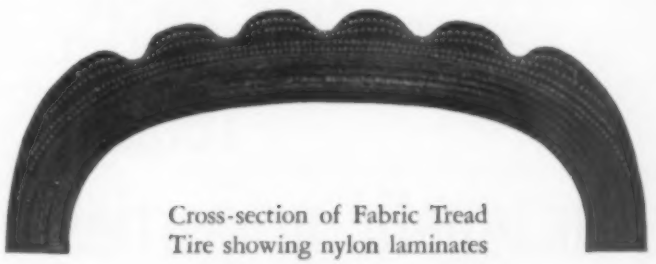

Cross-section of Fabric Tread Tire showing nylon laminates

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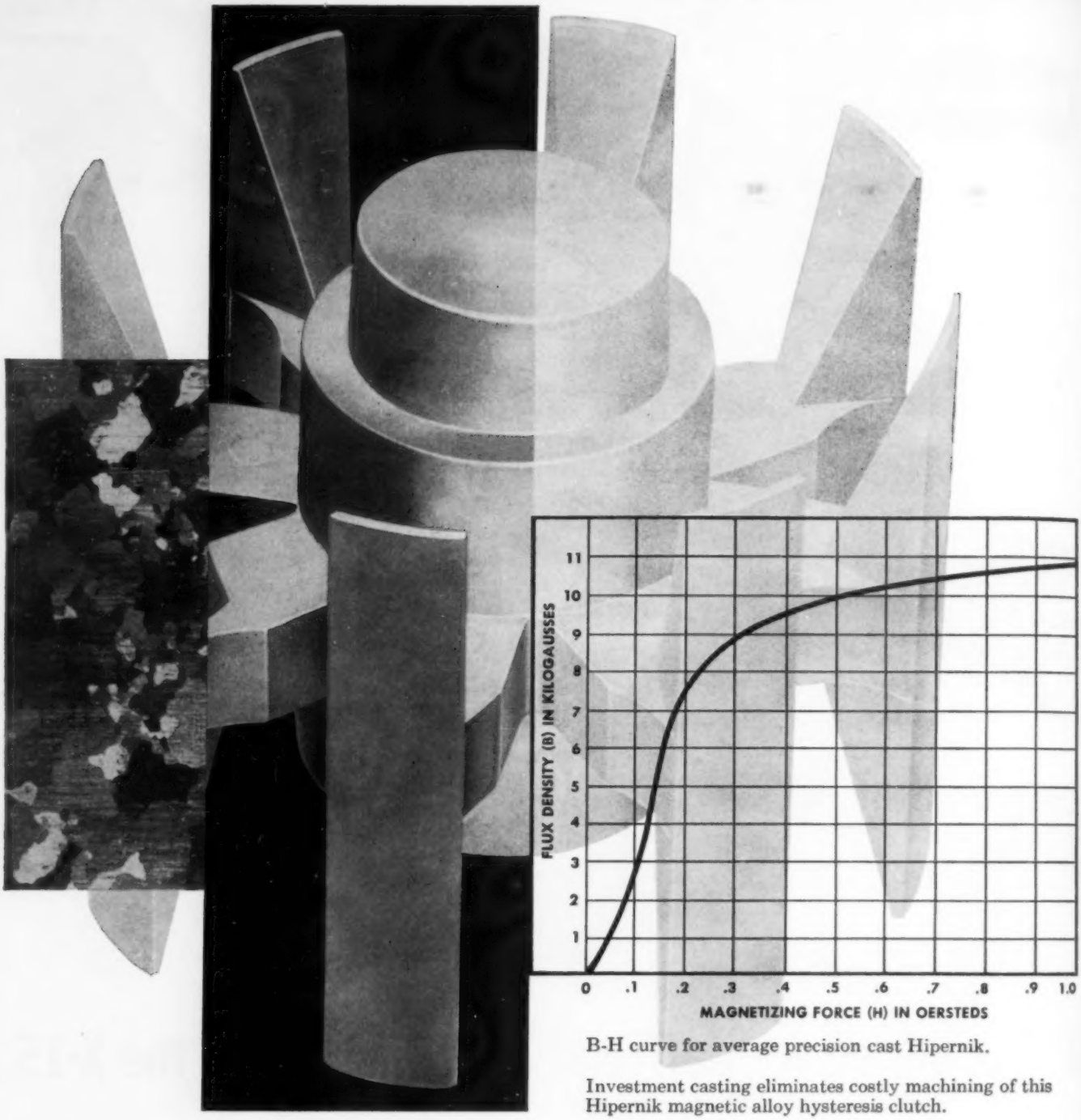

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washington countdown

Russian IRBM's . . .

are zeroed-in on every major installation in Western Europe, except two airbases in Spain, Rep. Daniel Flood (D-Pa.) told m/r. Flood said the IRBM's are 90% effective, compared with 50% for *Thor* which will be operational about March 1. Russia has 50 ICBM's but they are only 50% effective. And by the time the West has a 50% effective operational ICBM, the Reds will have 10 times as many with an efficiency of 90%, Flood said.

Look for Dr. Herbert York . . .

to take more and more direct authority over the services in R&D matters, up to having one-man authority over service R&D projects. If and when Roy Johnson should leave as head of ARPA, his successor will probably report to York instead of the Secretary of Defense.

A combined R&D budget . . .

for all services would be an advantage, a defense spokesman told reporters at the OSD budget briefing. That could easily be a forerunner of a complete combined defense budget.

3,000 mile *Polaris* . . .

poses no real problems, according to Rear Adm. William F. Raborn. He said the Navy is planning to put the longer-range IRBM on carriers and cruisers. It would be lengthened to carry more fuel. Cost is estimated at about $25 million.

Favorable Soviet lunar . . .

probe dates this month are Jan. 26-27. NASA will not launch Pioneer IV, however, until late February, using modified *Jupiter*.

To avoid any incident . . .

in connection with the launching of the first satellite from Vandenberg AFB, plans are to evacuate little railroad community of Surf (about 35 people) and lighthouse at Point Arguello. Only one man—reported to be the railroad telegrapher—will remain in Surf, about five miles south of the launching pads. *Discoverer* launching was scheduled as m/r went to press.

Space committees membership . . .

is shaping up two Democrats for every Republican. Nominations for the House standing committee on space and sciences list 16 Democrats and eight Republicans. The Democratic nominees are: Brooks, La., chairman; McCormack, Mass.; Miller, Calif.; Teague, Texas; Anfuso, N.Y.; Sisk, Calif.; Mitchell, Ga.; Quigley, Pa.; Hall, N.C.; Wolf, Iowa; Karth, Minn.; Hechler, W.Va.; Daddario, Conn.; Moeller, Ohio; King, Utah; and Roush, Ind. GOP nominees are: Martin, Mass.; McDonough, Calif.; Fulton, Pa.; Chenoweth, Colo.; Osmers, N.J.; Van Pelt, Wis.; Baumhart, Ohio; and Bass, N.H.

Democratic members of Senate . . .

standing committee on Aeronautical and Space Sciences are: Johnson, Texas, Chairman; Russell, Ga.; Anderson, N.M.; Magnuson, Wash.; Kerr, Okla.; Symington, Mo.; Stennis, Miss.; Young, Ohio; Dodd, Conn.; and Cannon, Nev. The Republicans will have approximately five members.

A Soviet space handbook . . .

published in January, 1958, indicates the Russian space program is on schedule. The handbook listed plans for five space shots of which the first three were to orbit earth satellites, the fourth was to hit the moon, and the fifth was to go into a solar orbit.

12 U.S. satellites will be launched . . .

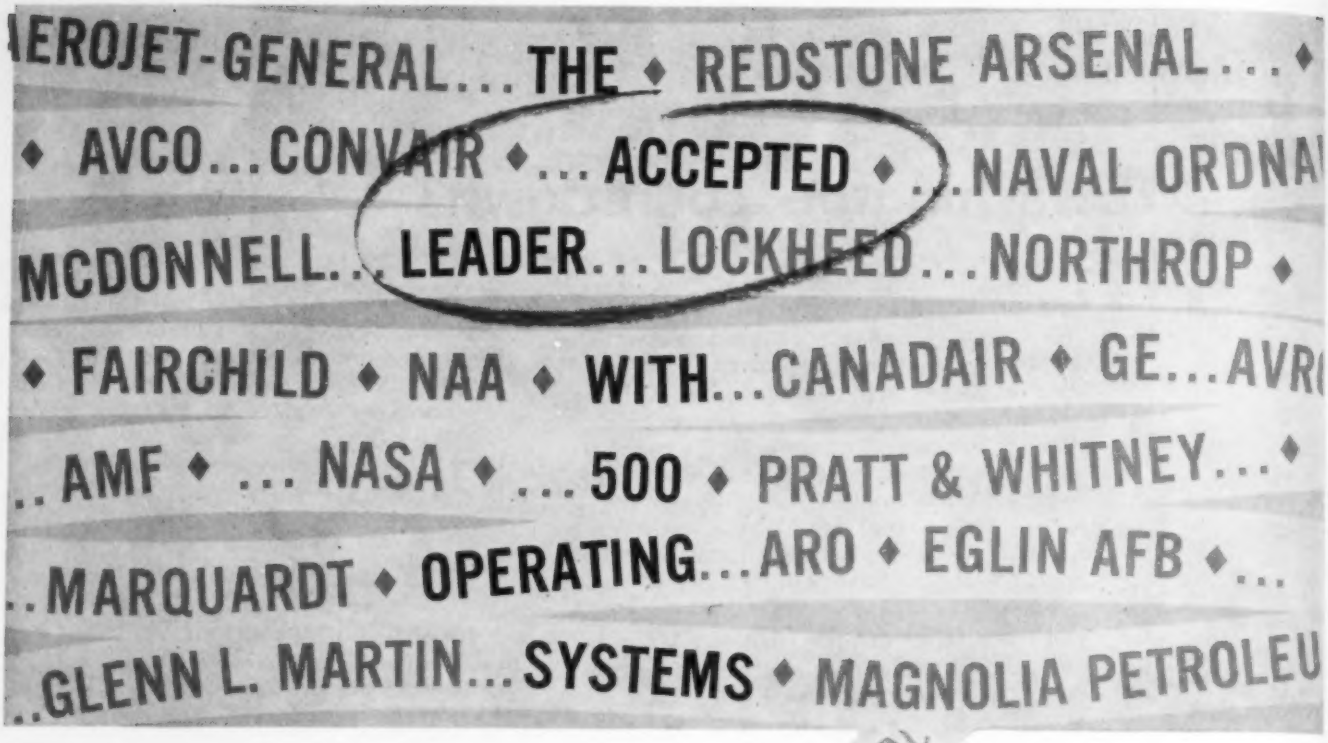
in 1959-60, according to Dr. T. Keith Glennan, NASA Administrator. Glennan said about 40 space probes with upper atmosphere sounding rockets are planned. He favors sharing the costs of satellite launchings with other nations, and said unofficial discussions already have been held between U.S., Canada, Britain, and Russia.

Russian report from 21st Century . . .

passes up trips to the moon as commonplace. Other accomplishments in next 100 years seen by 29 Soviet scientists in a book reviewed by Tass include: concentration on reaching Saturn, Jupiter, Uranus and Pluto; utilization of moon resources; and studying geology, physics and meteorology of other planets.

Many members of the ABMA team . . .

would like to see ABMA become a part of NASA, Dr. Homer J. Stewart, NASA's director of Program Planning and Evaluation, told members of the National Rocket Club. He said only time would tell what ABMA's future status will be, but it would be of great benefit to NASA.


AEROJET-GENERAL...THE ◆ REDSTONE ARSENAL...◆
◆ AVCO...CONVAIR ◆...ACCEPTED ◆...NAVAL ORDNA
MCDONNELL...LEADER...LOCKHEED...NORTHROP ◆
◆ FAIRCHILD ◆ NAA ◆ WITH...CANADAIR ◆ GE...AVR
..AMF ◆ ... NASA ◆ ...500 ◆ PRATT & WHITNEY...◆
..MARQUARDT ◆ OPERATING...ARO ◆ EGLIN AFB ◆...
..GLENN L. MARTIN...SYSTEMS ◆ MAGNOLIA PETROLEU

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industry countdown

One hundred contractors . . .

accounted for 74.2% of military funds from July 1, 1957 to June 30, 1958. This is an increase of 5.8% in contracts by the companies over fiscal year 1957. Twenty-four are engaged mainly in missile and aircraft programs and their awards amounted to 56% of the value of all defense contracts of $10,000 or more. Boeing and General Dynamics lead the list and their total percentage was as large as the net increase in the entire list of 100. Boeing contracts increased from $907 million in FY '57 to $2.131 billion in FY '58. Fifty-four percent of the contract awards were subcontracted with more than one-third going to small business.

Aerojet will expand . . .

solid propellant rocket facilities to meet the increased demands of new projects. An estimated $30 million will be spent for new construction at its solid rocket facility at Sacramento for work on *Polaris, Minuteman,* and *Dyna-Soar.* Expansion includes new machine shops, mixing plants, and static test stands. Employment has increased from 1,450 to 4,200 at the solid facility.

Delivery of *Bullpup* motors . . .

is underway from the Naval Propellant Plant, Indian Head, Md. for fleet evaluation. The solid propellant motor was designed by the Allegany Ballistics Lab., operated by Hercules Powder Co. for the Navy Bureau of Ordnance. The Indian Head plant is producing and loading the motors.

Flight test model . . .

of a variable thrust liquid rocket engine using pyrophoric fuels, already ground tested by its developer—NOTS China Lake—is expected soon. NOTS tested a 10,000 pound thrust version that is similar to one to be installed in the *X-15.*

First molybdenum casting . . .

produced by Bureau of Mines scientists at Albany, Ore., is termed "a major metallurgical breakthrough." The commercial value is still questionable but the process possibly could reduce the steps necessary to make missiles parts, reducing costs. A 30-lb. block of moly was melted in a water-cooled, copper-lined crucible with an electric arc in inert atmosphere. A rotating graphite cylinder mold forced the molten metal into a cylinder 4½ inches in diameter and 8 inches long.

***Jupiter* may become target missile . . .**

for *Nike-Zeus* or other AICBM systems under a Chrysler proposal. ARGMA has given the Detroit firm—already making personnel cutbacks because of phasing out of *Redstone* and *Jupiter* programs—a feasibility study contract. Conversion would consist of reducing complexity of system, including guidance, to make it less expensive.

Stavid Engineering will study . . .

weather conditions for the Army Signal Supply Agency with a $500,000 contract to develop a Sferics system for detecting and locating atmospheric conditions at long range.

Gulf Oil has exercised option . . .

to increase its financial interest in Callery Chemical Co. to 50% by buying a 25% interest. Callery, which opened its $5 million plant in Lawrence, Kan., recently, will continue its present management.

Contract for first ICBM pads . . .

at the Navy's Point Arguello missile facility has gone to Wells-Benz, Inc. of San Diego with a bid of $4.6 million. Contract includes one launch building, two pads and other facilities to be constructed under the direction of the Pacific Missile Range. Ralph M. Parsons Co. designed and prepared specifications under directions of AF Ballistic Missile Division.

Project *Discoverer* pad work . . .

underway at Point Arguello will, informally be completed in 9½ months. Construction involving more than 400 subcontractors calls for two structural steel towers, and two missile launching pads.

Ground support equipment . . .

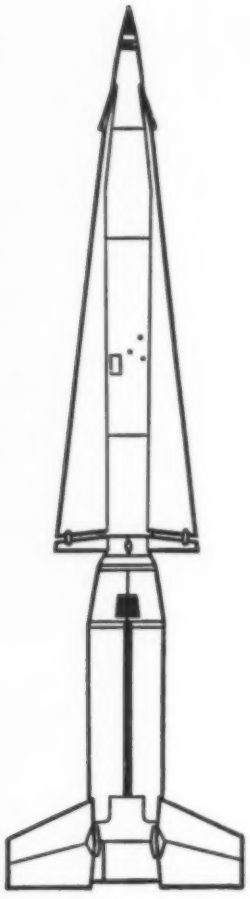
involves more than 50% of the dollar volume in missile systems, according to B. J. Meldrum of Chrysler Corp. Meldrum reports the *Redstone,* system requires a dozen major vehicles packed with intricate equipment to transport, set up, fuel, and fire the missile in the field.

The man:

A U.S. Army missileman working with Nike Hercules missile equipment. The modern Army relies heavily on the special skills and knowledge of men like this who are trained extensively in military schools, and supported technically in the field by Army Ordnance Corps, Western Electric and Douglas field service men.

The mission:

Defense of U.S. cities. Army Nike Hercules units are already on duty at many key points...have the important assignment of guarding against enemy aircraft.



The missile:

Douglas-built Nike Hercules, product of a Douglas-Western Electric-Army Ordnance team, has successfully engaged supersonic drone targets at altitudes well over 60,000 feet. Other drone targets have been destroyed up to 100,000 feet, and at ranges beyond 75 miles.

Status	Combat ready
Range	75 miles plus
Speed	Supersonic
Warhead	Nuclear or conventional
Service	U.S. Army

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JANUARY 26, 1959—VOL. 5, NO. 4

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Budget Holds $7 Billion for Missiles

$830 million for space exploration; *Minuteman, Hound Dog, Polaris, Nike-Zeus* programs to be accelerated in $40 billion defense budget. ARPA wants $455 million; NASA budget is $485 million.

by Clarke Newlon

WASHINGTON—President Eisenhower has presented to Congress a budget for Fiscal Year 1960 which includes $7 billion for missile weapons systems and $830 million for space projects.

The $7 billion figure was set by several budget interpreters, including Defense Department Comptroller, Assistant Secretary W. J. McNeil. The actual Office of Secretary of Defense figure for procurement and production of missiles was $4.162 billion, with the remainder being included in research and development and in ground support appropriations.

However, McNeil said that even the $4.162 billion figure included a great deal of non-missile money even to such items as the submarines which will fire the *Polaris*. (It does not include aircraft, he said, but certainly could include ground support equipment down to cement hardstands.)

Programmed by the National Aeronautics and Space Administration, the Advance Research Projects Agency and the Atomic Energy Commission is the $830 million for space exploration.

The overall U.S. budget totals $77.0 billion. Receipts are anticipated at $77.1 billion, leaving a space-thin $100 million margin of surplus.

Compared to last year, it looks like this:

	1959 (billion)	1960 (billion)
Receipts	**$68.0**	**$77.1**
Expenditures	**$80.9**	**$77.0**
	$12.9 (deficit)	**$ .1 (surplus)**

Of this total, national security gets $45.8 billion, with the Defense Department taking $40.9 billion as compared to $40.8 billion in 1959.

• **Comparison**—The FY 1960 Department of Defense budget (in billions), with FY 1959 in parentheses, is:

New appropriations (or new obligational authority, $40.850 ($41.138); buy money (or direct obligations), $42.707 ($43.435); pay money (expenditures), $40.945 ($40.800).

The three military services will share as follows:

Air Force. $18.7 billion (only slightly less than in 1959); Army, $9.35 billion (up slightly from 1959); Navy, $11.37 billion (down $400 million from 1959); OSD, $1.4 billion (up $170 million from 1959).

Added to the Defense budget will be approximately $0.7 billion appropriated by Congress for 1959 but not spent. Of this, $308 million goes for one *Polaris* sub and one submarine tender. Another $300 million is added to the *Polaris* missile program. Also

DEPARTMENT OF DEFENSE FISCAL YEAR FY 1960 BUDGET SUMMARY (Millions of Dollars)

TITLE	DIRECT OBLIGATIONS [Buy Money] TOTAL	ARMY	NAVY	AIR FORCE	OSD	EXPENDITURES [Pay Money] TOTAL	ARMY	NAVY	AIR FORCE	OSD
OPERATING COSTS	22,477	7,114	6,088	8,492	783	22,319	7,108	6,025	8,407	780
MILITARY PERSONNEL	11,965	3,908	3,276	4,066	715	11,934	3,897	3,264	4,058	715
Active Forces	(10,642)	(3,514)	(3,164)	(3,964)	....	(10,617)	(3,506)	(3,152)	(3,959)	....
Reserve Forces	(608)	(394)	(112)	(102)	....	(602)	(391)	(112)	(99)	....
Retired Pay	(715)	....	....	....	(715)	(715)	....	....	....	(715)
OPERATION AND MAINTENANCE	10,512	3,206	2,812	4,426	68	10,385	3,211	2,761	4,349	65
CAPITAL COSTS	20,231	2,793	5,993	10,817	628	19,030	2,422	5,727	10,293	588
PROCUREMENT	14,919	1,373	4,747	8,799	....	13,938	1,209	4,504	8,224	1
Aircraft	(6,795)	(85)	(1,866)	(4,845)	....	(6,265)	(126)	(1,778)	(4,362)	....
Missiles	(3,764)	(406)	(658)	(2,700)	....	(3,825)	(463)	(593)	(2,768)	....
Ships	(1,719)	(5)	(1,714)	....	....	(1,659)	(2)	(1,655)	....	(1)
Other	(2,641)	(877)	(509)	(1,255)	....	(2,189)	(618)	(478)	(1,094)	....
RESEARCH, DEVELOPMENT, TEST AND EVALUATION	3,722	1,047	969	1,102	605	3,384	909	922	1,011	543
MILITARY CONSTRUCTION	1,589	374	277	915	23	1,708	304	301	1,058	45
Active Forces	(1,519)	(336)	(266)	(894)	(23)	(1,644)	(267)	(291)	(1,041)	(45)
Reserve Forces	(70)	(38)	(11)	(21)	....	(64)	(37)	(10)	(17)	....
REVOLVING AND MANAGEMENT FUNDS	....	....	....	....	....	—405	—266	—155	—25	42
TOTAL	42,707	9,907	12,081	19,308	1,411	40,945	9,264	11,596	18,675	1,410

benefiting are KC-135 jet tankers, $55 million; strategic airlift, $140 million; *Hound Dog*, $48 million. The solid fuel ICBM *Minuteman* gets $90 million plus a 40% program increase.

Senator Henry M. Jackson (D-Wash.) told m/r *Minuteman* would get $251,200,000 from AF's fiscal 1960 budget.

• **New levies**—In the budget message the President made several proposals for new taxes, among them:

Raise motor fuel tax to 4½ cents per gallon, bringing in an estimated $690 million the first year and $900 million the second.

Raise aviation gasoline tax to 4½ cents per gallon and levy a new 4½-cent tax on jet fuel, bringing in about $85 million the first year and $100 million the second.

He requested authority for item veto of legislation including authority to reduce the amount of an appropriation as well as to strike out an item. He noted that the Presidents of both parties starting back as far as Ulysses S. Grant have recommended this.

Regarding the missile and space field, the President said:

"For the fiscal year 1960, research and development expenditures will be increased still further, with emphasis on space exploration, peaceful use of atomic energy and basic science. Extensive space exploration investigations are being initiated, utilizing satellites and probes. Development work is going forward on high energy fuel rockets, a million-pound thrust engine and a nuclear rocket engine.

"The Department of Defense will significantly increase expenditures for procurement of missiles and for development and evaluation of new weapons, while reducing expenditures for other procurement and for construction."

• **More bases?**—The first hint that the U.S. is concluding negotiations with Italy (or another NATO country) for use of the *Jupiter* IRBM came in the President's statement: "The first units of the IRBM *Thor* have already been deployed to the United Kingdom and additional units of both *Thor* and *Jupiter* will be deployed during the next 18 months."

The President said that in view of negotiations with Russia for suspensions, the budget does not provide for any nuclear weapons tests in Fiscal 1960. Testing grounds in Nevada and the Pacific will be kept on a stand-by basis, he said.

According to the message, the first operational *Atlas* missile will be at launching sites by June 30, 1959. Later in the budget book (Page 474) was the statement:

"Missile capability in the strategic forces will be strengthened by the activation of the first wing of strategic missiles." The Air Force declined comment, but it is assumed that this new strategic wing—which must be composed of the ICBM *Atlas*—will replace a wing of obsolescent B-47 bombers. (The Air Force drops from 105 to 102 wings, a reduction of one tactical and two air defense wings, during 1960).

• **Progress report**—The message noted that:

The first five submarines equipped to carry the *Polaris* will go into operation during Fiscal 1960 (although the solid fuel *Polaris* itself is considerably further off).

The liquid fuel ICBM *Titan* is coming along at a "rapid rate."

Development work is "progressing rapidly" on the second generation solid fuel ICBM *Minuteman*.

Production of the air-to-ground *Hound Dog* has been accelerated for the B-52.

The anti-ballistic missile *Nike-Zeus* is being accelerated.

The solid fuel *Pershing* and *Sergeant* missiles will replace the old liquid fuel *Redstone* and *Corporal* missiles.

No more appropriations are planned for *Jupiter* and *Thor* IRBMs after 1960 unless they are desired by our allies. (1960 money is sufficient only to carry out the earlier planned program.)

Construction is underway on a new ballistic missile early warning system.

Air Force interceptor squadrons, in addition to *Falcon* and *Sidewinder*, will be partially equipped with the nuclear-

NASA APPROPRIATIONS SUMMARY

	FISCAL YEAR 1959		FISCAL YEAR 1960
	APPROPRIATED	SUPPLEMENTAL ESTIMATES	REGULAR ESTIMATES
Salaries and Expenses	$ 83,100,000	$ 3,354,000	$ 94,430,000
Research and Development	50,000,000	20,750,000	333,070,000
Construction and Equipment	48,000,000	24,250,000	57,800,000
TOTAL APPROPRIATIONS	$181,100,000	$48,354,000	$485,300,000
Transfers from Department of Defense	$154,619,532	....	....
TOTAL NEW APPROPRIATIONS	$335,719,532	$48,354,000	$485,300,000

NASA R&D PROGRAMS—Fiscal Years 1959 and 1960

PROGRAM	FY '59 (In millions)	FY '60
AIRCRAFT, MISSILE AND SPACECRAFT RESEARCH (Support of NASA plant, JPL plant, and research contracts)	$ 13.995	$ 33.026
SCIENTIFIC INVESTIGATIONS IN SPACE (Sounding rockets, earth satellites, lunar probes, deep space probes, Vanguard program)	110.563	118.344
SATELLITE APPLICATIONS INVESTIGATIONS (Meteorology, communications)	8.100	28.000
SPACE OPERATIONS TECHNOLOGY* (Manned space flight, space rendezvous techniques)	37.661	73.000
SPACE PROPULSION TECHNOLOGY (Solid fuel rockets, high-energy fuel rockets, 1-million pound single-chamber engine, nuclear rocket engines, space engines, auxiliary power units)	29.000	64.200
SPACE SYSTEMS TECHNOLOGY (Advanced vehicle systems, booster recovery systems, orbiting space laboratories)	1.000	5.000
SUPPORTING ACTIVITIES (Tracking and data acquisition)	4.300	11.500
TOTAL PROGRAM	$204.619	$333.070

* Supplemental Estimate, FY '59—$20.750

ARPA R&D OBLIGATIONS

PROGRAM BY ACTIVITIES	1958 ACTUAL	1959 ESTIMATE	1960 ESTIMATE
1. Military sciences		$ 13,700,000	$ 18,000,000
3. Missiles and related equipment	$ 1,238,389	80,000,000	128,100,000
4. Military astronautics and related equipment	13,236,576	331,726,000	307,000,000
8. Programwide management and support	1,041,229	1,900,000	1,900,000
TOTAL OBLIGATIONS	$15,516,194	$427,326,000	$445,000,000

armed air-to-air rocket, the MB-1 *Genie*.

More than 70 *Nike-Ajax* and *Nike-Hercules* ground-to-air missile battalions will be in operation by the end of Fiscal 1960. These are in addition to an unnamed number of the longer-ranged *Bomarc* squadrons.

Work will continue at about the same level as in 1959 on the development of a nuclear powerplant for military aircraft.

The last of the old B-36 bombers in the SAC inventory will be replaced by B-52s armed with the *Hound Dog*.

The first B-58, intermediate range Mach 2 bomber, will be introduced into the SAC inventory.

• **NASA and ARPA**—The NASA budget for 1960 is $485,300,000 of which only $333,070,000 is for actual research and development, the remainder earmarked for salaries, construction and equipment. This $333 million must encompass all R&D work, including a fair portion not directly related to space work.

The ARPA budget is $455 million, including administration and certain research activities not connected with space work.

In addition, the Secretary of Defense has an emergency fund of $150 million to exploit breakthroughs in any field. It might or might not be used for space—might or might not be used at all. The AEC is included in the space budget for an unnamed amount, possibly for the nuclear rocket engine, but certainly a small sum.

The figure listed for overall space projects by the administration is, as noted previously, $830 million. Stripped of administrative and other details, the actual figure probably would more nearly approach $700 million for the entire national space program. There undoubtedly will be fringe benefits from research and developments of the services. The budgets of NASA, ARPA and Defense Department R&D are made out differently and cannot be compared in detail.

This is an explanation of the programed activities included in the ARPA breakdown, and to some extent that in R&D:

• **Military sciences**—Basic research in the physical and life sciences; applied research of importance for military purposes, operations research, and development of new materials, components and techniques.

Examples: radio astronomy, thermoelectric materials, masers, neurosensory phenomena, blood substitutes, boundary layer control and hydrofoils.

• **Missiles and related equipment**—Research, development, test and evaluation of strategic, tactical, air defense, and special purpose missiles, test vehicles and related equipment, including an extensive research and development effort on new techniques.

• **Military astronautics and related equipment**—The conductor programs directed at improvement of space technology for military purposes and the investigation of specific military applications of space vehicles. These include reconnaissance, communications, navigation and early warning of ballistic missile attack.

• **Program management and support**—The operation, management and maintenance of research, development and test facilities.

• **NASA program**—The NASA program for 1960 is aimed at improving design and performance of virtually all types of flight vehicles. Projects include:

Research on stability, control and similar problems encountered in a wide range of flight regimes from relatively slow take-off speeds to extreme conditions encountered by ballistic missiles, hypersonic aircraft, orbital vehicles and spacecraft.

Research on high energy rocket engines and fuels, on nuclear power for propulsion and ion and plasma propulsion systems for spacecraft.

Research on the response of structures and materials to environments imposed by flight at various altitudes and speeds.

Research on such problems as icing, turbulence, noise and fire in manned space craft operations.

Development of optimized satellite payloads, systems studies of spacecraft and overall control of satellite and space probe launching and tracking.

TOTAL R&D ESTIMATES FOR 1960

	IN MILLIONS		
	1958 ACTUAL	1959 ESTIMATE	1960 ESTIMATE
Research, development, test and evaluation appropriations	$2,502.7	$3,521.9	$3,722.4
Development, test, and evaluation support included in procurement appropriations	1,656.1	1,821.7	1,843.4
TOTAL, research, development, test, and evaluation including procurement support [1]	4,158.7	5,343.6	5,565.8

[1] Exclusive of military pay and military construction.

This table includes individual appropriations of the three military services, ARPA and the Defense Secretary's emergency fund.

In 1960 for the first time, figures for research and development will incorporate also the cost of tests and evaluation, which heretofore had been included in production and procurement costs. This will tend to make the R&D figure significantly higher and should reduce correspondingly the P&P funds. This table is for direct R&D obligations, that is, money which can be contracted for—buy money.

MISSILE EXPENDITURES LARGEST

Broken down by category, the Defense research, and development and evaluation figures on missiles and related equipment is three times as large as any other category.

SUMMARY OF PROGRAM BY ACTIVITIES	IN MILLIONS		
	1958 ACTUAL	1959 ESTIMATE	1960 ESTIMATE
1. Military sciences	$ 344.4	$ 360.3	$ 371.9
2. Aircraft and related equipment	442.5	472.6	487.3
3. Missiles and related equipment	904.3	1,341.8	1,437.6
4. Military astronautics and related equipment	17.4	345.9	309.1
5. Ships and small craft and related equipment	132.1	158.7	167.7
6. Ordnance, combat vehicles, and related equipment	179.1	188.8	235.0
7. Other equipment	323.6	379.9	430.8
8. Programwide management and support	135.1	137.8	133.0
9. Emergency fund and expired accounts	34.2	136.1	150.0
TOTAL DIRECT OBLIGATIONS	$2,502.7	$3,521.9	$3,722.4

Here's 1959 Outlook for Missile Materials

Metals will remain the mainstay, but competition from plastics will mean more teaming with ceramics

by Alfred J. Zaehringer

A review of 1958 developments shows a wide variety of available missile materials—many of them unknown a few years ago. It is predicted that within 10 years, an entirely new spectrum of missile materials will be with the industry. Such materials, now mostly a gleam in the minds of scientists, engineers, and industry, will be able to continuously handle temperatures of 3000°F, offer high strengths, be light and corrosion-resistant.

The Editors

DETROIT—Following last year's missile materials review (m/r, March, 1958), many laboratory items have entered the missile field as standard production items. During 1958, many new materials have appeared, and still other materials and techniques now shaping up point to expanding missile and space horizons. Many missilemen find it hard to keep in step with the ever-increasing tempo, which will continue—further complicated by hybridization or merging of fields and materials. This article will attempt to boil these down and present some highlights of the 1958 missile materials megamania.

• **Metals**—They continue to be the mainstay of the missile business. Plastics have started to take a chunk of this business and, as a result, metals have teamed up with ceramics (particularly cermets and ceramic coatings) to push forward the use range beyond the common 1600-1800F of ferrous alloys. Some of the high spots of 1958 in the metals field include:

• **Aluminum**—With a primary metal capacity of about two million tons per year, aluminum remains king of the light metals. Aluminum-lithium alloys are now battering at the thermal barrier of high supersonic aircraft and missiles. Alloys 5052 and 5454 are suitable for continuous temperatures of 200-400 F. Recently, foamed aluminum with a specific gravity of 0.1 (2.7 for regular Al) seems to open new missile structural applications. Aluminum also is seen gaining in nuclear reactor use and will probably be applied in atomic rockets. Aluminum remains an old faithful for shipping concentrated hydrogen peroxide and fuming nitric acid.

• **Lead**—The king of shielding materials, lead took a significant new step ahead in 1958. The USSR Central Research Institute of Ferrous Metallurgy claims it has made the "impossible"—a true alloy of steel and lead—by ultrasonic production techniques. If true, the report will mean an important structural and shielding material for atomic rockets.

• **Magnesium**—Though strongly supported with good engineering data by the relatively small magnesium industry, this ultra-light metal has had rough going in aircraft since the last war. Missile applications exist but are small. Big bugaboo that "mag" has had to fight is relatively high cost and the contention that production is too small for widespread use in a strategic area. Still, Mg has found some entrance into the missile field in the form of powdered fuel for solid propellants. Magnesium alkyls could, it is felt, offer advantages over aluminum fuels such as the pyrophorics.

• **Molybdenum**—Reserves of moly are expected to last about 100 years at the present rate of use. Under welding conditions, moly has taken several steps forward by processing under argon or helium atmosphere and, with slight additions of carbon (0.4-0.6%) could significantly improve fabrication techniques. It has been suggested that protective coatings are mandatory for high-temperature oxidation resistance. Moly has a higher "useful" strength at temperatures of over 1600 F than most known materials.

• **Nickel**—This vital metal continues to play a major role in high-temperature metallurgy. Inconel X missile seals have operated at 6000 psi and 1200 F, and this metal is also being used on underwater missile powerplants. Alloys 4130 and 4140 reportedly have not been holding up well in rocket chambers and auxiliary systems. The action of fuming nitric acid on nickel and cobalt pumps has also been rough. Inco says free world nickel capacity by 1961 will be nearly 700 million pounds.

• **Niobium**—Missile and nuclear technology has caused a steady growth of this metal's production. Half the density of tantalum, niobium is looking up for high-temperature oxidation resistance (to its melting point of 4400 F) in rocket engines and other hot spots.

• **Platinum**—Long useful in missile electronics, contacts, etc. The Soviets claim they have put this costly metal to use—in solid form—in certain rocket engine applications where high-temperature oxidation resistance is needed.

• **Rhenium**—Rhenium-moly thermocouples can be used to 3200 F and rhenium-tungsten alloys could push this application to over 4000 F for use in reducing (non-oxidizing) atmospheres.

• **Stainless Steel**—Missiles and the nuclear fields are large consumers of stainless steels. Missile acceptance of the AISI 200 types of stainless (manganese substituted for part of the nickel in the familiar 18-8) types could be significant. Stainless steels have shown promise in handling the white-fuming nitric acid rocket propellants. High-temperature strength research continues and several interesting combinations have turned up. AISI 400 alloys are good for applications in the 600-1400 F range while iron-base alloys (15-20% Cr and 27-32% Ni) have been developed for severe conditions. A new precipitation-hardened stainless PH 15-7 Mo (15% Cr, 7% Ni, 2.5% Mo, and 0.09% C) is suggested as a possible substitute for titanium in supersonic environments.

• **Tantalum**—High corrosion resistance (melting point 5300 F) continues to make this metal useful in electronics—particularly in miniature missile capacitors. The 1958 use of tantalum is estimated at a quarter of a million pounds.

• **Titanium**—With a sponge capacity of 27,000 tons per year, about 90-95% of U.S. titanium goes into supersonic vehicle skins, fasteners, and structural members. Crucible Steel recently introduced a heat-treated titanium skin alloy with a strength of over 250,000 psi. Much work is shaping up to determine the corrosion-resistance of titanium to the rocket

oxidizer red-fuming nitric acid. Manganese in the alloy or inhibiting with copper sulfate may eventually make titanium a good bet for a red-fuming nitric acid rocket tank of light weight and high strength.

Scaife Company is considering the use of titanium for rocket casings. Titanium Metals Corp. has an alloy (TI-155-A) which has a strength of 170,000 psi.

In summary, ferrous alloys (see Acme-Newport Steel Co. cover photo) will hold sway over the light metals for rocket construction. Recognizing their limitations above 2000 F, however, rocket makers will move to the exotic metals such as protected moly, with more and more "rare" metals (such as zirconium, tantalum, and niobium) finding extensive use for high-energy rockets systems dictated by fluorine, hydrogen fuels, and the "hot" solids.

Beyond the rare metals, wedding of ceramics (see table) and metals may push long-term operation to 5000-7000 F. Even beyond this, it is conceivable that a complete hybridization of all materials—metals, ceramics, and plastics—into one homogeneous "super material" will provide the ideal rocket substance: metals for high strengths at low temperatures and for shock resistance, ceramics for temperature resistance, plastics for flexibility and fatigue-resistance, and fibers for multi-dimensional stability.

Indeed, researchers are already pointing a way to the "plasticeramet." For example, silicon is a well-known constituent of metals. Silicon oxides, coupled with silicon polymers and quartz fibers could, some blue-sky scientists say, be "alloyed" with certain metals to form "plasticeramets"—the ideal container which can hold the long-sought "universal solvent."

• **Non-metals**—It is probably a safe bet that non-metals have made a startling rise in our technology spectrum. Contrasted to the metals which were known to primitive man, most non-metals of rocket interest today are, at the most, only several hundred years old. Non-metals have not helped metals pass the 1600-1800 F use range but are now actually challenging metals at the 2000-4000 F range. An example of this is the current parallel development of the ablating non-metals contrasted to the high-heat capacity heat sink metals. Some of the non-metal developments during the last year:

• **Ceramics**—Growing missile applications (see table) include use of such materials as glass, refractories, ceramets, and ceramic coatings. One dramatic ceramic application was the Rokide A (aluminum oxide) coating on the nose cone and shell of the *Explorer* satellite. Alternating stripes of this material kept instrumentation at a temperature of 50-86 F. Ceramic-coated moly rocket nozzles were able to take 3000 F under oxidizing conditions for 7-8 hours. Zirconium and thorium oxides are already being sought for temperatures above 5000 F. Plastification of brittle ceramics appears to portend an eventual new class of missile materials which can, like metals, take high thermal shocks.

• **Elastomers**—Much elastomeric work is now concerned with the evolution of new solid propellant fuel-binders and fluorine- or ozone-resisting materials. New fields, such as inorganic elastomers, are expected to evolve. Promising inorganic elastomeric systems might hinge on lithium, beryllium, boron, magnesium and aluminum compounds that are now rare laboratory curiosities.

• **Fibers**—Teflon fiber bags already are being used to hold concentrated oxidizing acids and may be used in expellant bags and for pre-packaged liquid rockets. Big fiber increase was glass fibers which hit a production of about 160 million pounds. Very considerable amounts go into reinforced plastics with missiles taking a good share. Carborundum's Fiberfrax (aluminum silicate) fiber can take continuous temperatures of 2000 F. Carbon Wool can take temperatures of 5400 F. Quartz fibers have hit a tensile strength of nearly 400,000 psi and appear to offer this strength for long periods at 1800 F.

• **Plastics**—Structural plastics appeared on both the *Explorer* and *Vanguard* satellites. Missiles such as *Titan, Terrier,* and *Sidewinder* are said to make extensive use of plastics. Nearly 200 million pounds of reinforced plastics were turned out—most of them thermosets.

MATERIALS OUTLOOK IN BRIEF

METALS

• **Aluminum . . .**
good high-temperature characteristics keep it king among light metals, likely to be used in atomic rocket.

• **Lead . . .**
tops for shielding. Soviet claim of steel-lead alloy might spell use in atomic rockets.

• **Magnesium . . .**
winning consideration as powdered fuel for solid propellants.

• **Molybdenum . . .**
a superior material at high temperatures, with touch of carbon it might be used to improve fabrication.

• **Nickel . . .**
used in missile seals and underwater powerplants, reportedly suffers in rocket chambers.

• **Niobium . . .**
production growing, looking toward use in rocket engines.

• **Platinum . . .**
costly but useful; Russians claim they've used it in rocket engines.

• **Rhenium . . .**
could be alloyed with tungsten for use in reducing atmospheres.

• **Stainless steel . . .**
now heavily used in missile and nuclear fields, it is subject to much research aimed at improving high-temperature performance.

• **Tantalum . . .**
high corrosion resistance makes for continued use in electronics.

• **Titanium . . .**
most U.S. output already goes into missiles. Alloy may be used for red-fuming nitric acid rocket tank.

NON-METALS

• **Ceramics . . .**
missile uses growing; plastification may lead to metal-like shock-resistance.

• **Elastomers . . .**
much work aimed at evolving solid propellant fuel-binders and fluorine- or ozone-resisting materials. New fields likely, including inorganic elastomers.

• **Fibers . . .**
Teflon bags now used to hold concentrated oxidizing acids, may be used in expellant bags and for pre-packaged liquid rockets. Various fibers can take high temperatures.

• **Plastics . . .**
already in structural use in satellites and missiles. Work continues to develop strength and durability at high temperatures.

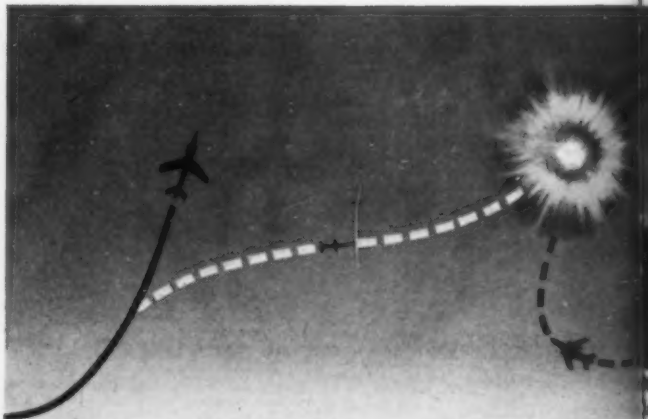
RAYTHEON

New Navy missile now with Fleetguid

Sparrow III is tenacious, accurate, lightning-fast. It uses a unique "wide-angle" radar target seeker which permits Navy pilots to launch missile from almost any approach angle and still score a hit. Once locked on target, Sparrow III guides itself, flying at several times the speed of sound, and unerringly intercepts the hostile aircraft despite evasive action.

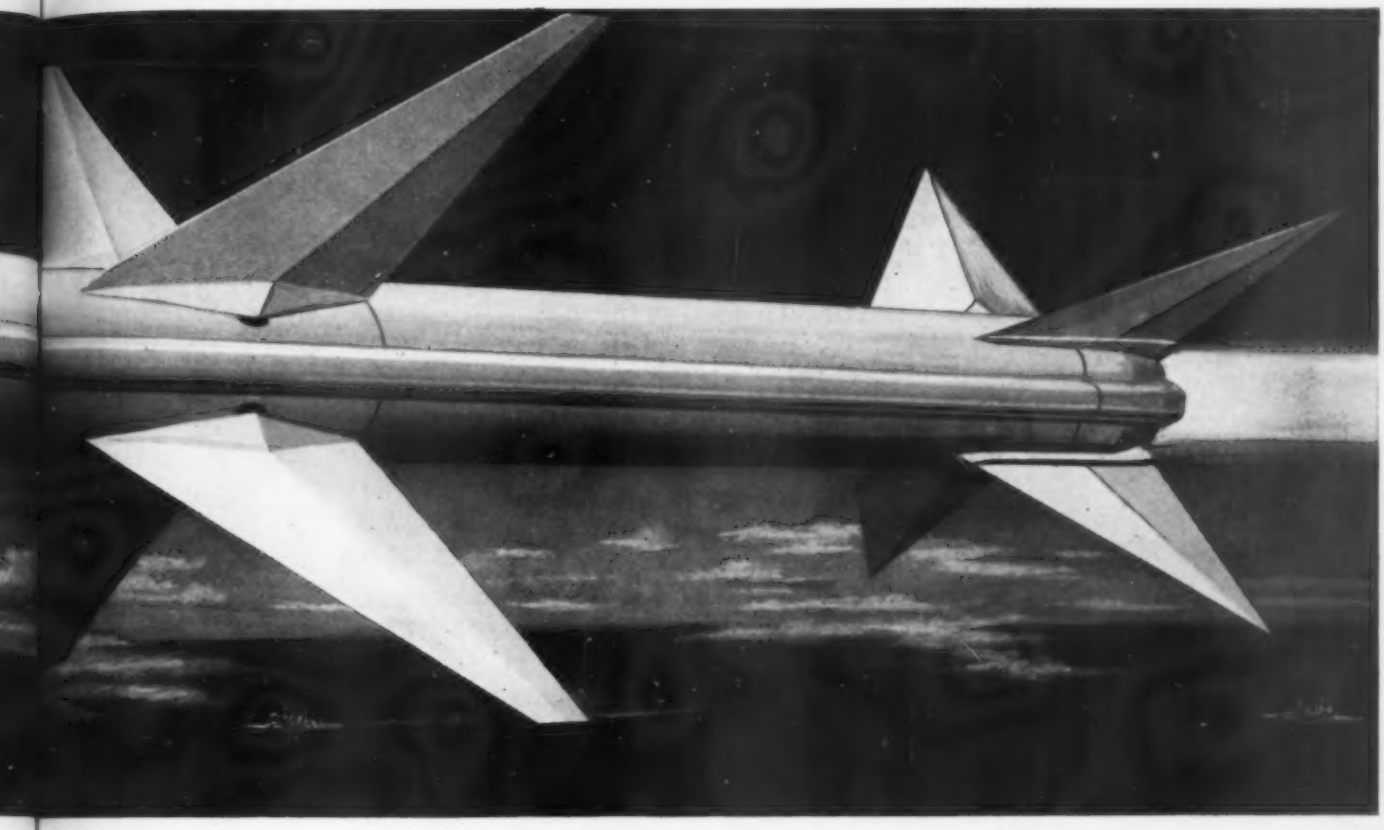
Now operational aboard Navy carriers, Sparrow III is slated for fighter squadrons throughout the Fleet. The missile is designed and produced for extreme reliability; has a powerful warhead and all-weather capability.

Raytheon is prime contractor for the Sparrow III, under the Navy's Bureau of Aeronautics. This new missile is another example of how the 37,000 men and women of Raytheon are contributing to national security.



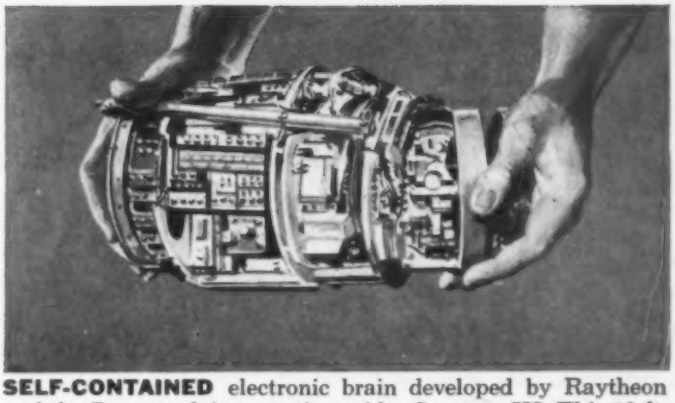
RAYTHEON SPARROW III weapon system employs new "wide-angle" radar. Navy pilot can launch missile from almost any angle and hit the target. Missile guides itself automatically, relentlessly destroys enemy aircraft in spite of evasive tactics.

SPARROW III



etguides itself, out-thinks target

OW BEING DELIVERED to the Fleet, Sparrow III arms the atest Navy jet fighters. This new rocket-powered missile is ighly reliable, has all-weather capability. It is extremely accu- ate and carries a powerful warhead.

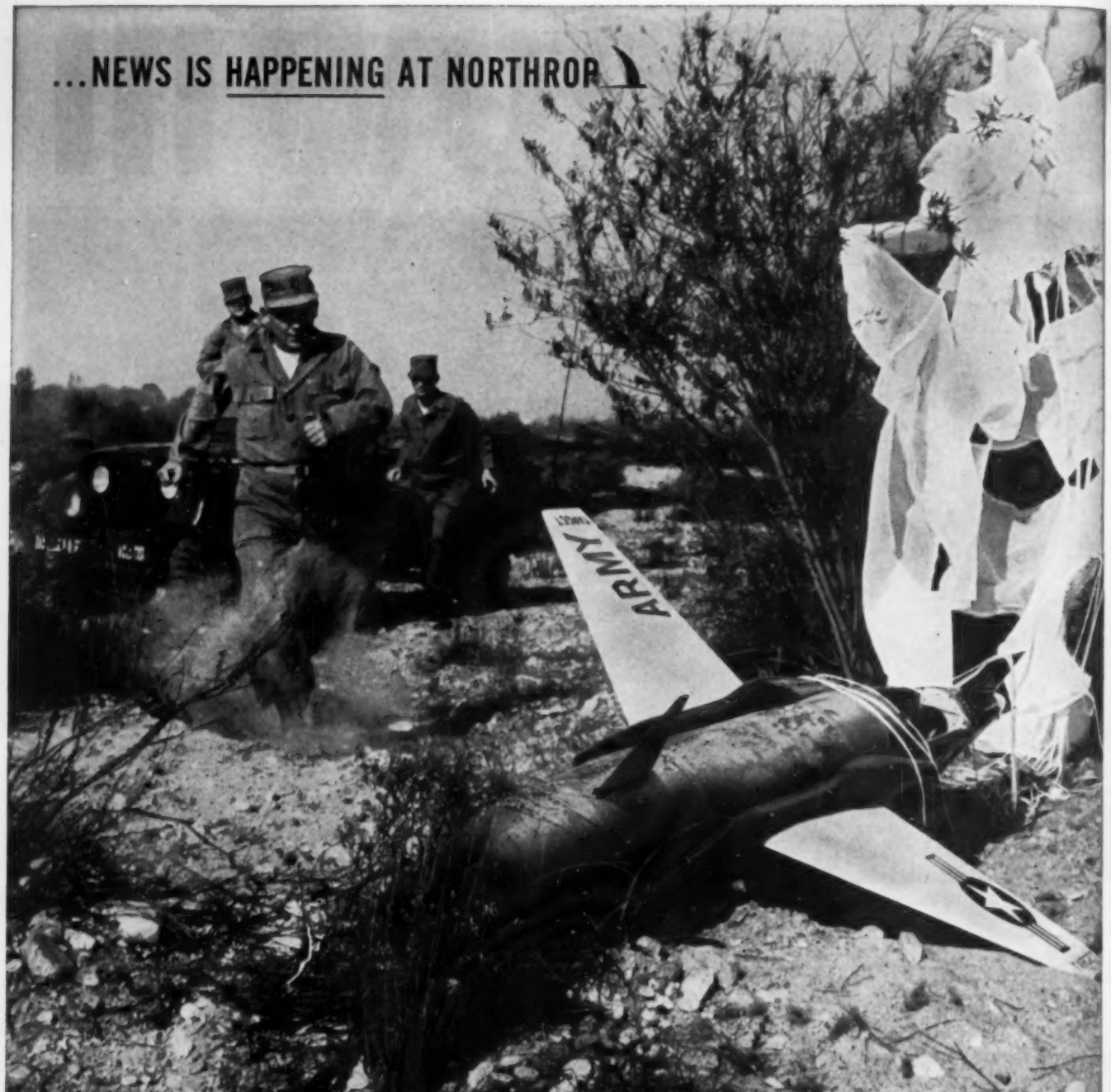


SELF-CONTAINED electronic brain developed by Raytheon and the Bureau of Aeronautics guides Sparrow III. This 12-ft. long, 8 in. diameter missile is engineered for high reliability and ease of operation in shipboard use.

RAYTHEON MANUFACTURING COMPANY, Waltham, Mass.

RAYTHEON

Excellence in Electronics



RADIOPLANE RP-76 SIMULATES NEAR-SONIC ENEMY ...ARMY MISSILEMEN SCORE HIT IN FIRST FIRING!

Place: Red Canyon Range, New Mexico. Time: minutes after an RP-76 high-altitude air-launching by Radioplane personnel. Event: Army missilemen sight RP-76 simulating an enemy weapon system approaching at Mach 0.9. They fire—for the first time against an RP-76—score a direct hit.

Responsible: the men of Battery C, 1st Missile Battalion (Nike-Ajax), 56th Artillery, U.S. Army Defense Command; the men of Radioplane's contractor-operated flight service program, backed by the more than 2,500 Radioplane drone specialists who designed and produced the RP-76.

This Army-Radioplane achievement typifies the result of Radioplane teamwork with all of the U.S. Armed Forces. Other current examples in development: the supersonic USAF-XQ-4A weapon evaluation target drone and the U.S. Navy's XKD4R-1 rocket target, two more members of Radioplane's complete drone family.

RADIOPLANE
VAN NUYS, CALIFORNIA, AND EL PASO, TEXAS
A Division of Northrop Aircraft, Inc.

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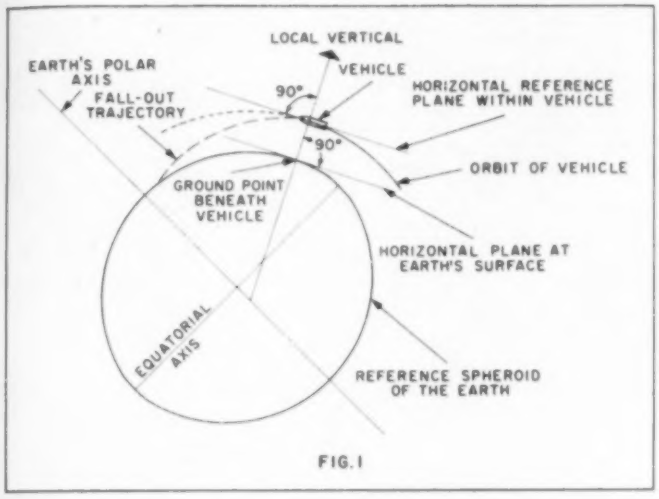

FIG. 1

Re-entry Navigation: 'Breakthrough' Is Not Required

by Raymond M. Nolan

WASHINGTON—The re-entry navigation problems of space vehicles and satellites can be solved today—without any major new breakthroughs—by use of horizon scanning with infrared means, according to a Sperry scientist.

The opinion was delivered by E. J. McCartney of Sperry Gyroscope in a paper at a recent meeting of the American Astronautical Society. McCartney urged use of the earth's horizon as a vertical reference for the re-entering body. He discussed the problems of detecting the horizon by infrared methods and indicated possible performances.

• **The problem**—Basis of the problem which McCartney proposes to solve is the need for a stable vertical reference or local vertical. The local vertical is the line which is normal to the surrounding earth's surface beneath the vehicle; it is the line perpendicular to the earth's reference spheroid at a point where the outward extension of the line passes through the vehicle. The local vertical (shown in Fig. 1) defines the ground point which is directly beneath the vehicle and establishes the direction of up or down.

Space vehicles have two uses for the local vertical: positioning the retrojets to produce the ballistic fallout path and, once within the atmosphere, manipulating the vehicular control surfaces to maintain a glide path toward the desired landing point.

One method of sensing the local vertical is to use the gravity vector, whose direction closely coincides with the direction of the local vertical, i.e., the gravity vector also is perpendicular to the surface of the reference spheroid. However, use of the gravity vector to establish the local vertical fails in the case of an orbiting satellite or a re-entering vehicle because they are partly or completely weightless. In this state, the gravity vector within the vehicle either vanishes or diminishes so greatly that it loses its reliability in the presence of other disturbances.

McCartney recognizes the availability of inertial guidance as a solution to this problem but claims that the inclusion of a system which can continuously extrapolate the direction of the local vertical from launching to final point is self-defeating. The size of a passive terminal guidance reference from the initial launching guidance, he says, would require an expensive, complex and heavy system, involving many instrumental uncertainties.

• **The earth itself**—But, says McCartney, the surface of the earth itself, seen from a proper vantage point, is a gravity reference completely unaffected by any motions of the vehicle. The mean free surface of the ocean, an equipotential surface, is everywhere perpendicular to the gravity vector and for centuries has been used as a vertical reference in measuring celestial altitudes with the marine sextant. Also, the rim of land surface, even when broken by mountains, approximates a vertical reference when viewed from a sufficient height. Scanning by infrared methods would provide both day and night operation during almost all types of surface weather.

The geometry of horizon-scanning is shown in Fig. 2 with the vehicle assumed to be at an altitude of 200 miles. The horizon is sensed at point "A" by moving the field of view of one infrared detector up and down in the plane of the diagram so that the detector is first looking out into space just above the horizon and then looking at the earth's surface just below the horizon. The thermal discontinuity or radiation gradient at the horizon provides the phenomenon to be detected. Scanning the horizon at diametrically-opposite point "B" furnishes another tangential line. Bisection of angle AOB by instrumentation establishes a plane normal to the earth's surface at point Q; line PQO is the edge-trace of this plane.

The plane then provides a reference for pitch control of the vehicle. When the horizon is scanned at two additional diametral points, 90 degrees around from points "A" and "B," and the resulting tangential lines bisected, a second normal plane is produced for controlling the roll attitude of the vehicle. According to McCartney, these two planes, normal to the earth's surface and perpendicular to each other, intersect along line PQO which becomes the direction of the desired local vertical within the vehicle.

Using the author's example, for a vehicle altitude of 200 miles, the horizon lies all around at a slant range of 1300 miles, not allowing for refraction. The depression angle to the horizon is 18.2 degrees. At the slant range of 1300 miles, a 2-mile mountain will subtend an angle of about 5 minutes of arc. However, since mountain ranges usually occupy only limited horizontal angles, errors can be substantially re-

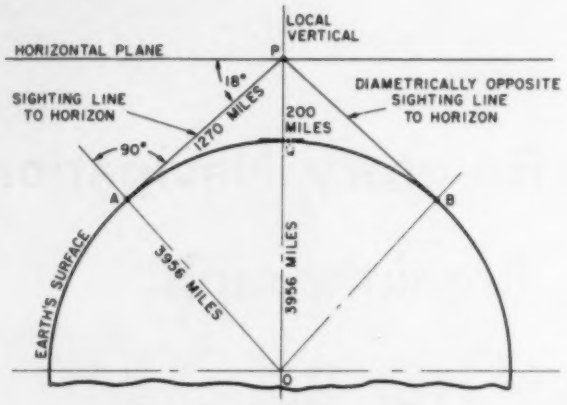

FIG. 2

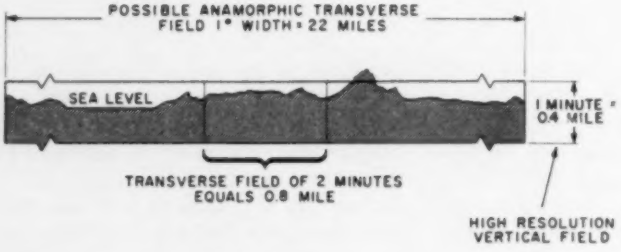
POSSIBLE ANAMORPHIC TRANSVERSE FIELD 1° WIDTH = 22 MILES
SEA LEVEL
1 MINUTE = 0.4 MILE
TRANSVERSE FIELD OF 2 MINUTES EQUALS 0.8 MILE
HIGH RESOLUTION VERTICAL FIELD

FIG. 3

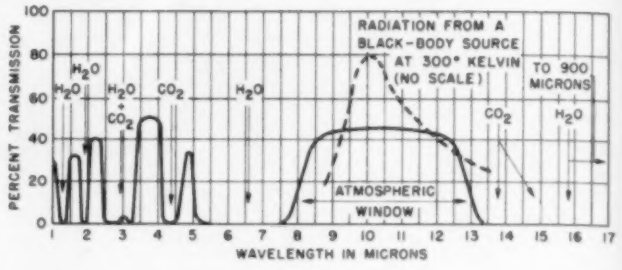

FIG. 4

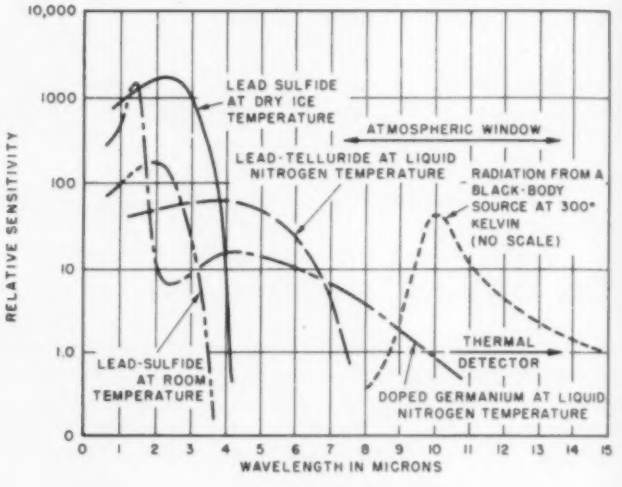
RELATIVE SENSITIVITY
LEAD SULFIDE AT DRY ICE TEMPERATURE
ATMOSPHERIC WINDOW
LEAD-TELLURIDE AT LIQUID NITROGEN TEMPERATURE
RADIATION FROM A BLACK-BODY SOURCE AT 300° KELVIN (NO SCALE)
THERMAL DETECTOR
LEAD-SULFIDE AT ROOM TEMPERATURE
DOPED GERMANIUM AT LIQUID NITROGEN TEMPERATURE
WAVELENGTH IN MICRONS

FIG. 5

HORIZON-SCANNING geometry is illustrated at top left. Lower left figure illustrates the averaging effect possible with proposed method using broad lateral field to average terrain irregularities. Illustration at top right shows infrared absorption at sea-level. Lower right hand diagram contrasts various types of infrared detecting elements.

duced by employing a field of view whose lateral extent is much greater than the vertical.

This tends to give an averaging effect as shown in Fig. 3. McCartney says an anamorphic type of optical system might have some value here, accepting a wide lateral field of view with resultant lateral compression of the image and allowing use of a smaller area detector.

Several things affect the performance of the proposed system. They can be roughly grouped into natural factors and instrumental factors. The author further divides natural factors into the earth-surface horizon and the atmospheric horizon.

• **Natural factors**—When the earth's horizon is scanned vertically by a thermally-sensitive infrared receiver having a small vertical field of view, a radiation temperature increment averaging several degrees C exists. Slope and amplitude are functions of local meteorological conditions at the horizon. The gradient is steep enough to permit an infrared receiver with a small vertical field of view and with a response peaked around 300 degrees Kelvin, to resolve the horizon line to within a few minutes of arc.

Some of the problems in discerning the thermal horizon formed by the earth's surface are caused by attenuation of radiation by absorptions due to carbon dioxide and water vapor and by scattering due to haze, fog and cloud particles. Unfortunately, the particles, in addition to scattering the desired radiation out of the sighting path, also scatter unwanted radiation into the path.

Wavelengths from 7 to 14 microns —the atmospheric window—seem to provide a good region of operation since these wavelengths take in the bulk of radiation from a 300-degree Kelvin source (fig. 4). However, the sides of this window close in with increasing amounts of water vapor along the sighting path.

Absorption bands are another consideration. If all-weather operation is required, the effects of scattering by atmospheric particles are important. When the wavelength is great compared to the particle size, the scattering varies inversely as the 4th power of the wavelength. Haze particles with a diameter of 1 micron or less are not as important as fog and cloud particles with a diameter of 20 to 60 microns.

McCartney holds some hope for all-weather capabilities by going to the very long infrared wavelengths of 1 millimeter and greater. He says that although much less energy is radiated along these wavelengths, the earth-sky contrast is not necessarily made worse. He adds that Sperry is currently conducting a research program in connection with the detection of these millimeter waves.

The atmospheric horizon is another factor. McCartney compares the troposphere and the atmosphere and says that the troposphere is probably acting as a good radiator. Seen in great optical depth, it is no doubt radiating as a black body at the shorter wave

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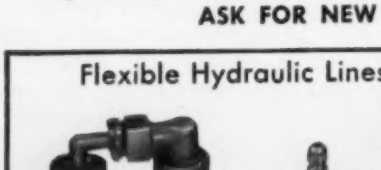

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absorption bands and also over the spectral expanse from 14 to 900 microns. In contrast with the stratosphere which emits very little self-radiation, he sees the tropopause as a usable horizon for an infrared detector. The disadvantage exists, however, of establishing a new horizon once the vehicle has descended below the tropopause.

• **Instruments**—In the category of instrumental factors, McCartney contrasts photoconductive elements with thermal detectors. Of the photoconductive elements, only lead sulfide attains high sensitivity without cooling—but its response does not extend to the longer wavelengths. Of the refrigerated detectors, he says, only doped-germanium reaches the atmospheric window from 7 to 14 microns with any response (see Fig. 5).

Thermal detectors such as the thermopile, bolometer and Golay cell respond less to shorter wavelengths but maintain flat response over a broad region. The Golay cell is still a usable detector up to 1 millimeter. The time constant of the Golay cell is only 5 to 10 milliseconds, but McCartney claims that this is adequate since the fleld to be scanned is small and the relative angular velocity between vehicle and horizon is not great.

Window materials are the final factor that McCartney considers. He assumes that the scanner window will be about 3 to 4 inches in diameter. He discounts rock salt, potassium bromide and KRS-5 for various reasons such as fragility, susceptibility to moisture and difficulty of fabrication in the required size. He says silver chloride would be adequate with a suitable coating.

Astronautics Tests

Jan. 14—*Hawk* fired at White Sands made direct hit on 1400-mile-an-hour *Q-5* target missile.

Jan. 15—*Bomarc* launched from Eglin AFB in the first missile test from the operational training facility. Missile made direct hit on jet drone 87 miles away.

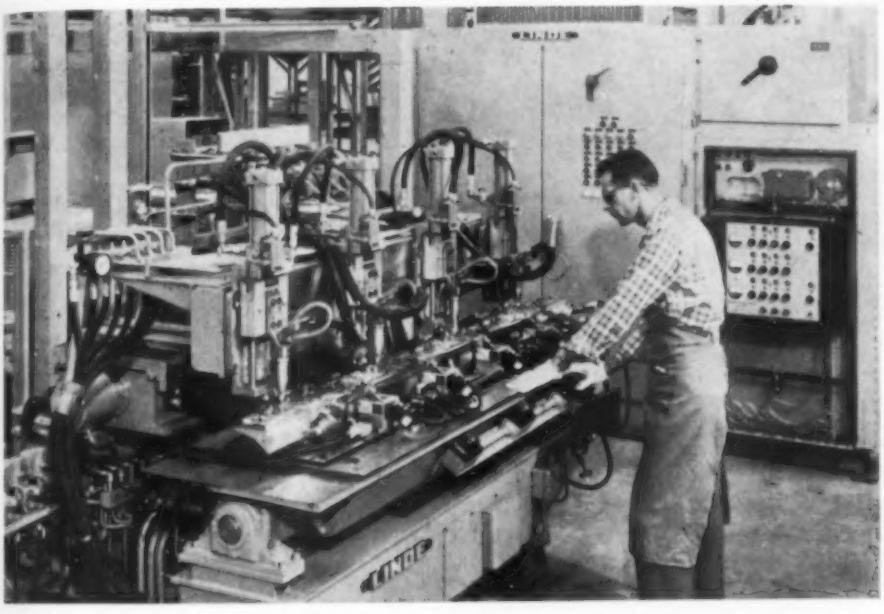
Jan. 15—*Atlas* travels less than 200 miles in 18th flight test. Range destructed when engine system malfunctioned.

Jan. 18—Chance Vought "battlefield mobility concept" missile—*Project Firepower*, fired successfully at Redstone Arsenal.

Jan. 19—*Polaris* AX-4 fired. First described as "fully successful" later, termed "partial success."

new missile products

Multiple Welds Produce 'Problem' Parts



A tape-controlled, multiple-torch Heliarc spot welding machine, invented and developed by **Linde Co.,** Div. of **Union Carbide Corp.,** is being used by Convair Div. of General Dynamics Corp. to produce "problem" parts for *Terrier* surface-to-air guided missiles.

Convair engineers ran into production problems on some *Terrier* parts, such as control and dorsal fins, because they could be welded from only one side. Since conventional resistance spot welding techniques require that both sides of a joint be accessible, it was impossible to use these methods.

Heliarc spot welding, however, requires access to only one side of the joint. Welds are produced by a tungsten electric arc, shielded by inert argon gas. Since the heat of the arc melts the metals through the joints, the second side of the joint need not be accessible. Heliarc spot welding thus is ideal for joining parts in which two or more surfaces must be welded to a core.

The process utilizes positive and instantaneous arc ignition. This starting system eliminates all high-frequency interference problems and avoids the contamination problems of retract starting. Electrode life is increased by a factor of four over high-frequency starting and process reliability is greatly increased.

Convair contracted with Linde to design and construct a tape-controlled programmer and welding machine that could produce up to four identical parts at one time. The machine has four torches, arranged so four parts may be welded simultaneously. Hydraulic controls position the torches horizontally and they are raised and lowered pneumatically.

Under subcontract to Linde, two other firms supplied parts for the Convair installation. The Welding Machine Division of Expert Tool & Die Company supplied mechanical and hydraulic components, while a punched-tape program control unit was supplied by Farrand Controls Corp.

Circle No. 225 on Subscriber Service Card.

Multi-Use Piston Hydraulic Pumps

A new line of constant pressure, variable displacement, piston type hydraulic pumps, specifically developed for high-temperature applications in aircraft and missile hydraulic flight control systems, is now available from **Pesco Products Division, Borg-Warner Corp.**

The new pump design features increased reliability at higher operating speeds, insensitivity to type of fluid used, high-temperature bearings, all-metallic O-rings and seals, and a minimum of rotating parts.

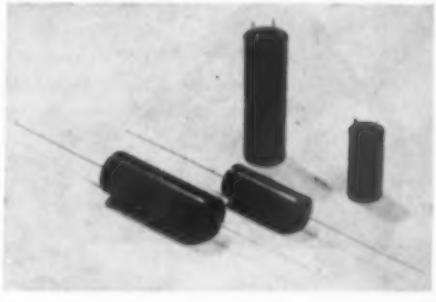
Available with either single or dual pumping elements, the pumps are designed to run at speeds up to 7500 rpm. The pumps are recommended for use with fluid temperatures up to 550F and ambient temperatures up to 600F.

The new line of variable delivery piston type units cover a range of capacities from 3 to 27 gpm, when operating at rated speed. System pressures for these capacities are generally 3000 psi, although some pumps, such as the dual unit type, are used in 4000 psi systems.

Circle No. 227 on Subscriber Service Card.

Electrolytic Capacitors Have Long Shelf Life

Aluminum electrolytic capacitors, designed for miniaturized electronic equipment, have been developed by **P. R. Mallory & Co. Inc.,** which dubbed them the "PET" series. The new line uses a new low-resistance electrolyte which gives long shelf life at temper-



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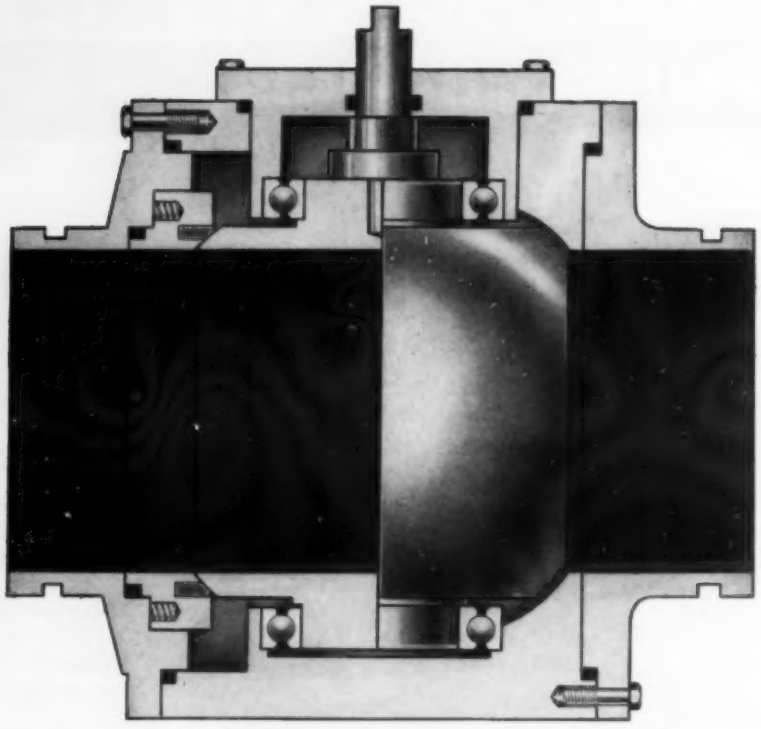
The Editor



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Hydromatics, Inc.

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Pasadena, 35 N. Arroyo Pkwy., RYan 1-7448 / Denver, 829 15th St., AMherst 6-2714 / Washington, 1413 K St. N. W., STerling 3-3612

Circle No. 9 on Subscriber Service Card.

atures up to 85°C. The new design produces stability of capacitance—variation from −30° to +85° is within the range of −15% to +10%.

The new capacitors provide more capacity for their size than other comparable aluminum electrolytic. Maximum capacity in the 5/8" by 1" case size ranges from 550 microfarads at 3 volts to 86 microfarads at 50 volts.

Two designs available are the printed circuit model in single, dual and triple ratings for vertical mounting; and the axial lead design for printed circuit and other electronic applications, available in single and dual ratings.

The series covers a temperature range of −30°C to +85°C, and has a capacity tolerance at 25°C of −10% to +250%. The units are encased in plastic with an epoxy end-seal. The sizes vary from 3/8" x 5/8" to 5/8" x 1 7/8". Ratings cover voltages from 3 to 50 WVDC, and capacities of 1500 to 1 microfarad total per unit.

Circle No. 234 on Subscriber Service Card.

200 KC Oscilloscope Has Twin Amplifiers

A new 200 KC oscilloscope with dual trace presentation is now available from the **Hewlett-Packard Company.**

The instrument, Model 122A, has twin vertical amplifiers and a vertical

function selector. The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 KC rate.

Model 122A triggers automatically and has a maximum sensitivity of 10 mv/cm. One knob selects any of 15 calibrated sweeps from five microseconds/cm to 200 milliseconds/cm in a 1-2-5 sequence. Sweep accuracy is ±5%.

Other features include a "times-5" sweep expander which provides maximum speed of 1 microsecond/cm on the 5 microsecond/cm range. Trace normally runs free, syncing automatically on 0.5 cm vertical deflection, but a knob adjustment eliminates free-run and sets trigger level as desired between −10 and +10 volts.

Circle No. 232 on Subscriber Service Card.

Static Power Inverter Has 20,000-Hour Life

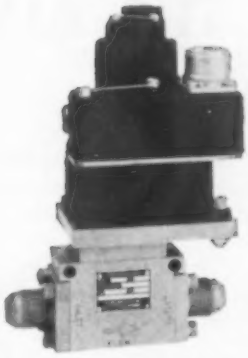
A solid state static power inverter, utilizing transistor and magnetic amplifier circuitry to convert an 18-30

volt dc source to an 115 volt, 400 cycles per second, single phase ac source, has been developed by **Magnetic Amplifiers, Inc.**

Designed to produce a stable power output of 80 VA, the unit was created for use in missiles, aircraft and ground equipment, and has other applications in automation, atomic energy programming, and ignition systems. Its output is stabilized in voltage and frequency for wide variations of input voltage, load, load power factor and ambient temperature.

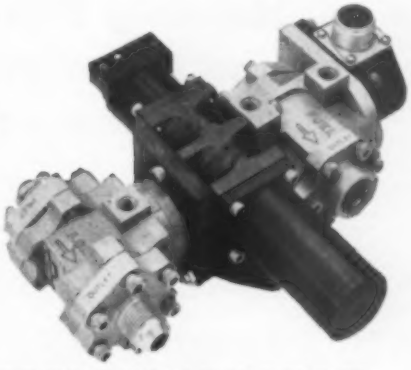
The power inverter is said to have a life expectancy of 20,000 hours under continuous operation, in comparison with the nominal 2,000-hour life of conventional generators. It has no moving parts or bearings to lubricate, functions noiselessly, and contains no vacuum tubes.

Vibration range of the unit is from 10 to 2,000 cycles. It withstands high shock to 30 times its weight, and will not spark at any altitude. It will withstand variable input voltages up to 40



½" MOTORIZED FLO•BALL VALVE
100% flow efficiency — for general service media up to 3000 psi

Extremely light weight and compact, suitable for a wide range of aircraft and missile applications, both airborne and ground support. Provides perfect sealing and 100% flow efficiency for general service media (jet fuels, hydraulic fluids, water, alcohol, helium, hydrogen, oxygen, etc.) at pressures up to 3000 psi and temperatures from —65° to 200°F. The DC motor actuator includes automatic current shut-off and a positive Geneva-Lock mechanism. Valve is of bi-stable design — in the event of electrical power failure, the valve will remain in its last position, either open or closed. Included is a built-in microswitch for remote observation of valve position. Flanges, which are removable and interchangeable, may be specified per AND-10050, AND10056, NPT or ASA.



FLO•BALL PROPELLANT VALVE
Dual line flow control of cryogenic media at 1000 psi

For simultaneous flow control of Liquid Oxygen and Fuel, this prop valve provides zero leakage control of a ⅝" LOX line and ½" Fuel line at pressures up to 1000 psi and temperatures as low as —350°F. A single-acting, spring-return pressure actuator drives a precision mechanical linkage which controls both valves, thus insuring constant timing. The valves are extremely fast acting, with response times as short a 10 milliseconds. All dynamic sealing is double with a vent between seals for maximum safety. A sealed, rotary action snap switch permits remote observation of valve position. Valve flanges, available in standard or special styles, are removable and interchangeable.

Hydromatics, Inc.

70 Okner Parkway, Livingston, New Jersey

Circle No. 9 on Subscriber Service Card.

IT'S ALWAYS "WINTER" *SOMEWHERE*

Heating Blankets and other Woven Heating Elements by SAFEWAY can make your COLD problems OLD problems!

To keep sensitive equipment, fuels, propellants and lubricants at correct operational temperatures in any cold environment, controlled heat must be delivered with utmost dependability. SAFEWAY delivers it — *everywhere.*

Among the wide variety of heating blankets and woven-wire heating elements successfully engineered by SAFEWAY to meet tailor-made specifications are:

- **heating blankets for honeycomb and metal-to-metal bonding**
- **de-icing units for airfoil surfaces**
- **heating elements for launching equipment and for airborne gyros, cameras, computers, servos and batteries — for missiles or aircraft**
- **radiant heating panels for industry**
- **defrosting units for industrial and commercial refrigeration**

FOR YOUR COPY OF A FACT-FILLED FOLDER, PLEASE WRITE:

If it has to be heated (and the "it" can be just about anything), you can rely on SAFEWAY engineers to study your problems and — without any obligation — submit an appropriate recommendation.

Safeway HEAT ELEMENTS INC.

680 Newfield Street • Middletown, Connecticut

Circle No. 25 on Subscriber Service Card.

volts and may be repeatedly switched on and off without generating frequency transients or malfunctioning.

Built according to military specifications, the static power inverter includes such features as an output of 115 volts, adjustable to plus or minus 5%; output frequency of 400 cycles per second, plus or minus 1%, regulation of 1½% for load variations from no-load to full-load; power factor of minus 0.5 to plus 0.5; maximum distortion of 5%; and ability to operate in ambient temperatures ranging from -55°C to +71°C.

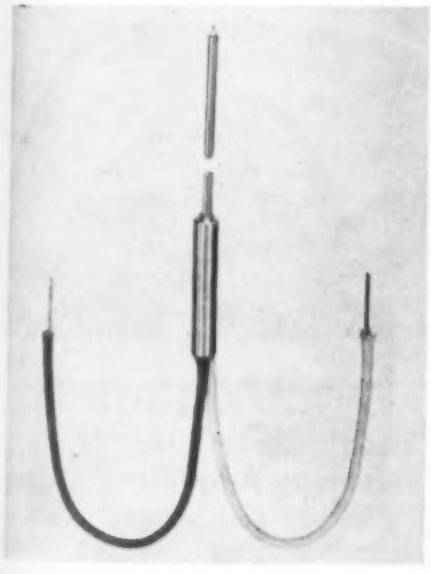
Another feature of the component permits manual adjustment of output from 105 to 125 volts and frequency control in a range of plus or minus 3 cycles per second.

Measuring 4 in. in height, 6 in. in width, and 6 in. in length, the static power inverter weighs 10 lb.

Circle No. 233 on Subscriber Service Card.

Thermocouples Made by Con-P-Pak Process

Con-P-Pak thermocouples are designed to meet the severe demands required of controls and instruments



used in rocket engines, melting furnaces, nuclear reactors and in the processing of liquid hydrogen, alcohols and other materials difficult to handle. A number of metal combinations are used, such as copper-constantan for temperatures down to –300°F and rhodium platinum for temperatures over 1600°F.

The thermocouples are made according to the new Con-P-Pak process with conductors encased in specially processed ceramics and surrounded by chemically clean metal sheaths. Various junctions and tips are available as well as several connectors.

Insulation resistance between wires and sheath ranges up to 100 megohms at 500 V.D.C. and dielectric strengths to 2000 V.A.C.

Circle No. 228 on Subscriber Service Card.

Tiny Hydraulic Pump/Motor Operates at 24,000 RPM

Now available for all aircraft and missile installations requiring a smaller, lighter pump or motor in hydraulics systems, the "Hummingbird," a new 24,000 rpm, miniature, piston-type hydraulic pump/motor has been recently introduced by **Borg-Warner's Pesco Products Div.**

Performance runs of 50 hours at 24,000 rpm have been made, with the pump delivering 2.5 gpm at 3000 psi. No appreciable loss in efficiency has been shown at the end of these runs.

The Hummingbird pump/motor features spherical piston rings, all-metal O-rings and seals, a new type of universal joint, and all-steel construction.

The pressure-locked spherical piston rings maintain high efficiency through-

MicroRold®

stainless steel soars with

ATLAS ICBM

on first full range flight!

U. S. missile program one step nearer to complete operational capability.

On the evening of November 28, 1958, a 100-ton ATLAS lifted from its pad at Cape Canaveral and arched majestically into the heavens. 30 minutes later its nose cone shot into the Atlantic, marking the first successful completion of its fully-programmed distance of 6300 statute miles.

The main part of the ATLAS structure is literally a huge fuel tank, the shell of which is thin gauge MicroRold stainless steel. Important factors in selection of stainless steel for the outer skin of the ATLAS are—great strength at both high and low temperatures, resistance to corrosive exotic fuels and good workability.

The stainless skin, supplied exclusively by Washington Steel, requires extremely close control of mechanical properties and gauge tolerance which are regularly produced through Washington Steel's long experience with precision rolling equipment.

NOW IN ORBIT!

4½ ton third stage
118 to 625 mile altitude
December 18, 1958

WASHINGTON STEEL CORPORATION

1-H WOODLAND & GRIFFITH AVENUES
WASHINGTON, PA.

Circle No. 10 on Subscriber Service Card.

out operating life. They minimize possibility of seizure due to fluid contamination, thermal shock, or cylinder distortion, and eliminate side-load wear.

Metallic O-rings and seals, coupled with all-steel construction of the Hummingbird pump/motor, allow operation of the unit with fluids of temperatures from –65° to 550° F. This universal joint has three equally spaced rollers attached to each end of the universal shaft, transmitting the drive rotary motion smoothly and uniformly at all speeds.

Weighing 1.1 pounds in a steel body 4.125 inches long, with a displacement of .025 cubic inches, the Hummingbird may be operated in either rotation. No modifications or adjustments are necessary for its installation as a pump or as a hydraulic motor. It may be run directly from high speed turbines or similar drives.

Circle No. 226 on Subscriber Service Card.

Small Solid Batteries Deliver 1600 Volts

A group of solid state batteries, small enough to hold in the palm of your hand but capable of delivering a combined voltage of 1600 volts, are now available from **Patterson, Moos Division of Universal Winding Co.**, Jamaica, N.Y.

The batteries, called "Dynox", come in four different sizes—Dynox "95",

with a 95 volt potential in 0.14 cubic inches, Dynox "190," with a 190 volt potential in 1.15 cubic inches, Dynox "380," with a 380 volt potential in 1.57 cubic inches, and Dynox "950," with a 950 volt potential in 2.87 cubic inches.

Circle No. 230 on Subscriber Service Card.

Lox Pump Motor Delivers 60 gal/min.

Recently developed by the J. C. Carter Co. for pumping liquid oxygen of liquid nitrogen is an electric motor driven two stage centrifugal pump. Designed to deliver 60 gallons per minute against a 550 ft. head, this pump is particularly suited for installations where light-weight, compact design is important.

Circle No. 229 on Subscriber Service Card.

Electrically Isolated Telemetry Amplifier

Endevco Corp. offers a new airborne subminiature amplifier, Model 2617, to be used with high impedance transducers such as piezo-electric and capacitive devices. When used with Endevco accelerometers and Endevco Model 2980 insulated mounting studs, the complete system is electrically isolated from ground. The Model 2617 is protected against humidity (potted).

It offers compact design features: 1000 megohm input impedance with less than 50 mv residual noise (shorted input), broad range of 2 cps to 20 kc and low current requirement (5.0 milliamps). The amplifier is 7.5 cubic inches in volume and weighs 7 ounces.

Circle No. 231 on Subscriber Service Card.

SPACE

Cape Canaveral is the site of the nation's major terminus to space. This terminus is managed by Pan Am. Our Guided Missiles Range Division has prime responsibility for management, operation and maintenance of the 5000-mile Atlantic Missile Range extending from Florida through the Bahamas to Ascension Island and beyond.

Because of these operations and the division's dynamic growth, we can offer high level physicists, mathematicians and electronic engineers truly unique opportunities in missile test and space probe engineering.

For an investigation of your future in the space age with Pan Am, please address a confidential resume to Mr. C. R. Borders, Assistant Division Technical Manager, Pan American World Airways, Inc., Patrick Air Force Base, Cocoa, Fla., Dept. B-3.

PAN AM GUIDED MISSILES RANGE DIVISION
PATRICK AIR FORCE BASE, FLORIDA

Circle No. 12 on Subscriber Service Card.

Fluoroflex®-T (*Teflon*®) hose for high pressure systems now tested to the new Resistoflex standard of

250,000 impulses

instead of industry-recognized 100,000 cycles

dept. 199 RESISTOFLEX Corporation, Roseland, N. J.

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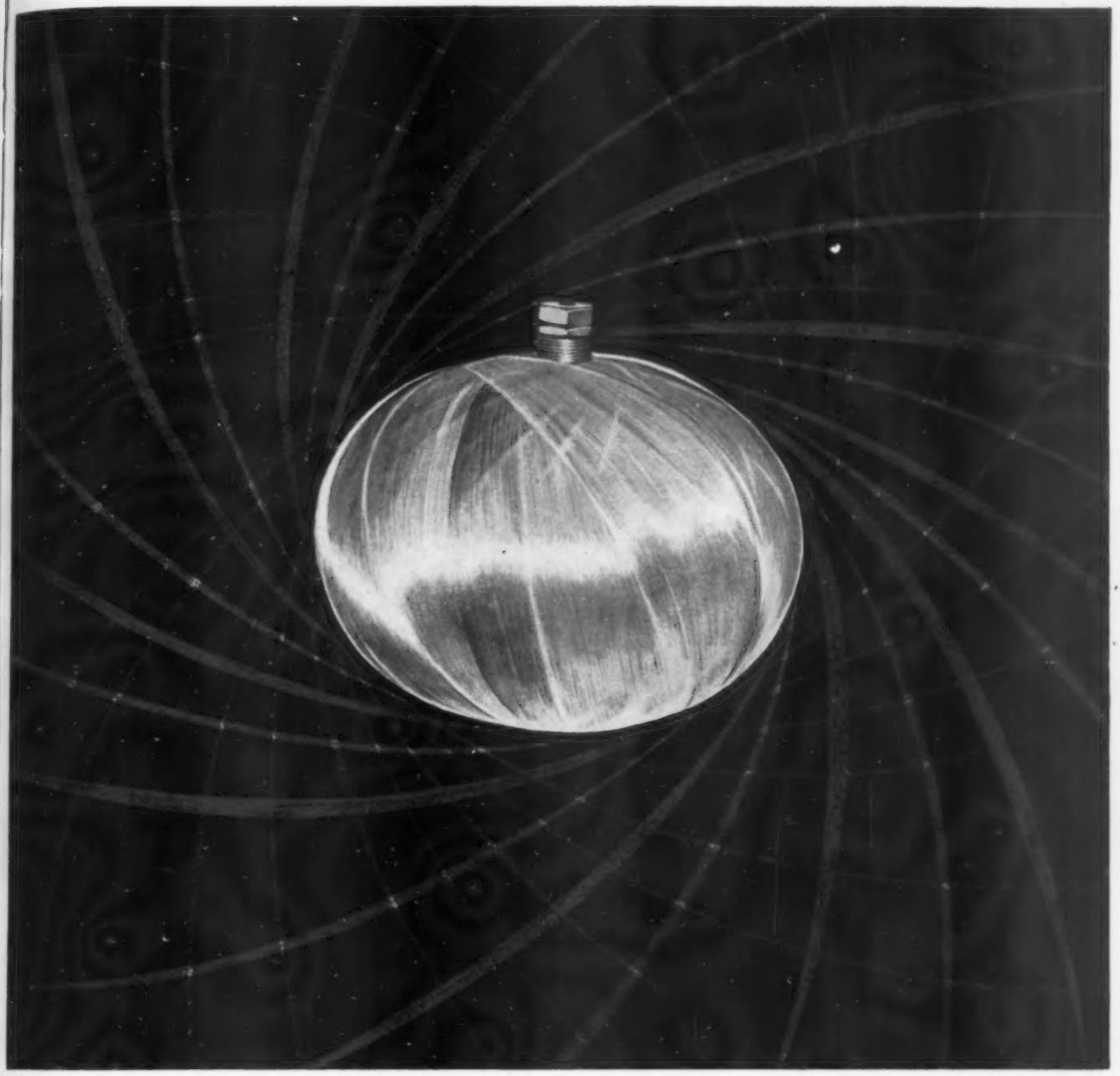

HOW HIGH THE PSI? (BRUNSWICK "BOTTLES" UP TO 200,000)

Here's the big news in the pressure vessel field. Brunswick's new, unique Strickland "B" Process (SBP) now results in filament-wound plastic vessels with the greatest strengths ever obtained. At the same time, vessel weights have been drastically pared down. Brunswick can create vessels (from that shown above to air bottles and rocket motor cases) with these specifications: Hoop stress values in the range of 175,000 to 200,000 psi. Burst strength values: up to 150,000 psi. Weight: 20 to 40 per cent *less* than that of *any* previously built plastic vessels. Temperature limits: up to 600° F. Super tough SBP vessels are also ideal for components that must stand up to extended operating cycles, and can be mass produced in compound and monocoque shapes.

For proposed or existing projects involving pressure vessels, Brunswick offers skillful assistance in the design, development and fabrication stages. For more details concerning the higher strength—lower weight advantages of SBP components, write or call: The Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler St., Muskegon, Michigan.

BRUNSWICK

MAKES YOUR IDEAS *WORK*

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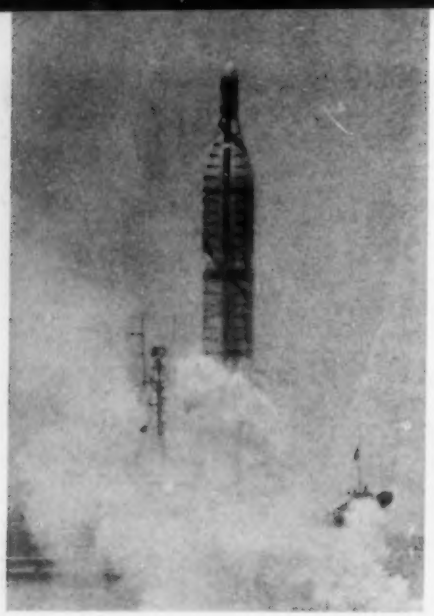
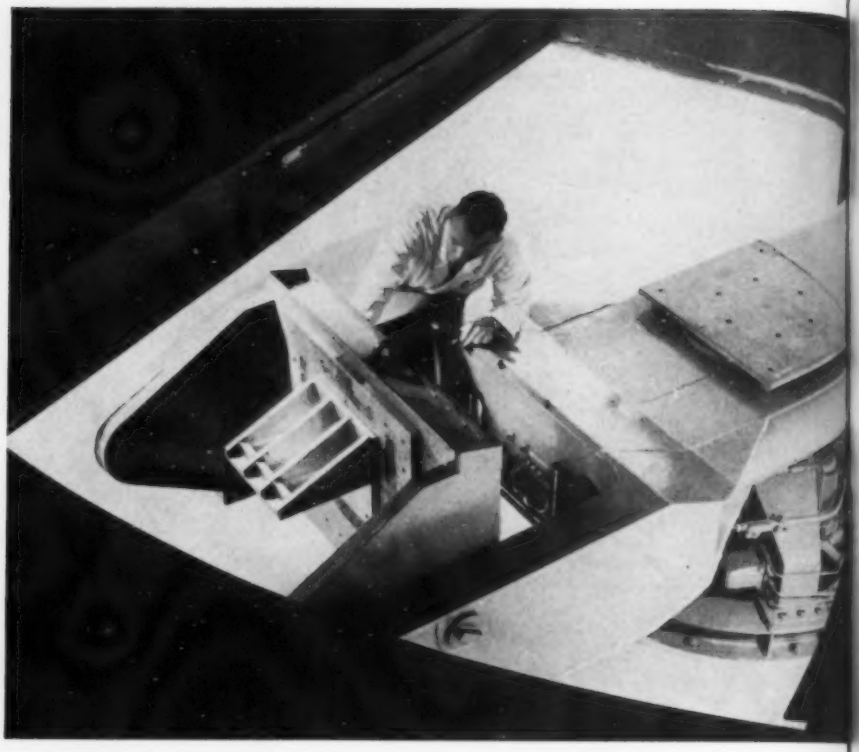


(left) Pop-up test of Navy Polaris IRBM.

(below left) One of the Santa Cruz test stands with dynamic thrust mount to simulate flight environment. Vibration oscillator functions during static firings.

(below right) Large centrifuge for environmental testing has unique shaker attachment to provide vibration simultaneously with high G-loadings.



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

...Test

Testing is a vital part of every stage in the development of missile and space programs at Lockheed Missile Systems Division.

The Division maintains one of the most completely equipped missile and space test laboratories in the world. Equipment includes: altitude, temperature and humidity chambers; shaker and vibration systems; G-accelerators; and apparatus capable of performing chemical, metallurgical, plastic, heat transfer, hydraulic, pneumatic, shock, acceleration, sinusoidal and random vibration, structural, electrical, and electronic tests. Static field testing; research and development testing on controls; testing in ordnance and hydraulics and high-pressure gas and propulsion systems are conducted at the 4,000 acre, company-owned test base in the Ben Lomond mountains near Santa Cruz, California.

As weapons systems manager for such major, long-term projects as the Navy Polaris IRBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7; and other important research and development programs, Lockheed is engaged in expanding the frontiers of technology in all areas.

Flight testing is conducted at Cape Canaveral, Florida; Alamogordo, New Mexico; and Vandenberg AFB near Santa Maria, California; in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already have flight-tested reliability. This new concept of flight testing is a major contribution and has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Underwater launch tests—including studies of cavitation, wave simulation and skip motion—are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. In addition, structural and other tests are performed at Hunter's Point Naval Shipyard, California.

If you are experienced in any of the various phases of testing, we invite your inquiry. Positions also are available for persons experienced in physics, mathematics, chemistry, or one of the engineering sciences.

Write: Research and Development Staff, Dept. AAA-29, 962 W. El Camino Real, Sunnyvale, California; 7701 Woodley Avenue, Van Nuys, California; Suite 745, 405 Lexington Avenue, New York 17, New York; Suite 300, 840 N. Michigan Avenue, Chicago 11, Illinois.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

Lockheed / MISSILE SYSTEMS DIVISION / SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA CAPE CANAVERAL, FLORIDA · ALAMOGORDO, NEW MEXICO

Circle No. 20 on Subscriber Service Card.

propulsion engineering

by Alfred J. Zaehringer

Stabilization of free radicals is being attempted at National Bureau of Standards. High concentrations of the large radicals (such as oxygen or nitrogen) apparently are easier to obtain than hydrogen. Percentages obtained so far are: hydrogen 0.01-0.1%, nitrogen 0.2-6%, and oxygen 1-16%. Adding inert atoms and storage in a strong magnetic field might increase percentages and effect stabilization.

Liquids to watch for 1959: nitrogen tetroxide and perchloryl fluoride for pre-packaged systems; liquid hydrogen for high performance systems; slight additional increase of fluorine use; LOX up slightly; peroxide about the same; nitric acid down.

Propulsion, according to John Sloop of NASA's Lewis Research Center, is the key to success in space flight. Propulsion always seems to lag behind vehicle development. Good example of our lag: U.S. moon probes and the recent Soviet moon shot. U.S. missiles tend to be underpowered; Soviets tend to throw in a little more power reserve.

Shrouded pulsejet engine, says the Air Force in one of its latest guided missile manuals, may be one way to extend the simple pulsejet into the supersonic operation range. Duct around engine keeps the air flow outside engine at low Mach number. It eliminates the pressure differences between ram pressure at the inlet valves and static pressure at the tail pipe exit.

Auxiliary power for space missions, ARDC estimates will be something like this during the next 10 years: 1 kw for hard impact on moon, 300 mile earth satellite, and circumlunar return; 1.6 kw for soft moon landing, landing on Mars or Venus, manned circumlunar and return, and controllable orbit satellite; 5 kw for manned space station; and 10 kw for roundtrip to Mars and Venus. Output of 7 kw/lb of generating equipment is acceptable for several years but this will have to improve later to 50-250 kw/lb.

Ignition of solids is undergoing considerable research. Work in Zurich has shown that high intensity light can initiate detonations. At the University of Cambridge, electric fields have been used for ignition. On the other hand, neutrons, alpha particles, and other large fission fragments were not capable of producing ignition hot spots. At 10^4 roentgens, there is no great effect. To 10^7 roentgens only decomposition rates are changed. At Princeton University, shock waves have been used to ignite solid propellants (double base and composite). A helium shock wave of Mach 4 can ignite the solids. Aberdeen Proving Ground reports shock initiation of solids. University of Utah work outlines the transition from deflagration combustion to detonation when an inert solid medium interrupts deflagration.

Sweet propellants? Paris researchers have prepared sucrose (common sugar) nitrate. Properties indicate a low cost, high-energy solid propellant ingredient.

Ammonium nitrate can be used as an igniter material. Thiokol's Elkton, Md. Division has patented a starter-sustainer mix with AN, potassium dichromate, charcoal, and paraffin.

NOW WEEKLY COLUMN

With this issue of m/r, Propulsion and Chemistry Editor Alfred J. Zaehringer's column will be a weekly feature in response to requests of readers who desire more timely and interesting information in these fields.

How KENNAMETAL* Sealing Rings...

Help to Withstand High Temperatures . . . A jet engine shaft seal of Kentanium,* a titanium carbide, operating without lubrication at 15,000 surface feet per minute at 1000°F and 0.6 pounds pressure per lineal inch of circumference outperformed every other material tried. Kentanium is stress-free, dimensionally stable, maintains great strength and provides exceptional resistance to abrasion. It is providing all of these advantages on many applications . . . at temperatures up to 2000°F and as high as 5000°F for momentary service.

Help Solvent Separators to Resist Abrasion . . . On this job, Kennametal rings of Grade K96 were installed, replacing conventional seals which had at no time given more than two months' service and had sometimes failed in only 30 hours. Kennametal rings were inspected after six months in service, showed no perceptible wear and were returned to service. The customer predicts an ultimate service advantage of 50 to 1.

Help to Power Rockets . . . Here the sealing rings are used to handle red fuming nitric acid. After extensive testing of materials, rings made of Kennametal K501, a platinum-base composition, were chosen. The manufacturer reports: "Kennametal ring sealing results have been far superior to any other material with no indication of seal face wear." This was after the best life of the rings previously used had been exceeded.

For details, write for 24-page Booklet B-111, "Characteristics of Kennametal" . . . and 12-page Booklet B-444 which describes "Kentanium." KENNAMETAL INC., Dept. MR, Latrobe, Pa.

*Trademark

3172

INDUSTRY AND KENNAMETAL ...Partners in Progress

Circle No. 13 on Subscriber Service Card.

Operations Research

Mathematicians, Physicists and Engineers with experience or strong interest in Operations Research on large-scale automated systems will be interested in the major expansion program at System Development Corporation.

SDC's projects constitute one of the largest Operations Research efforts in the history of this growing field. The projects are concerned primarily with man-machine relationships in automated systems in a number of fields, including air operations. The application of new and advanced digital computer techniques is particularly important in optimizing these man-machine relationships.

Senior positions are among those open. Areas of activity include: Mathematics, System Analysis, Forecasts, Cost Analysis, Operational Gaming, Design Analysis, Performance Evaluation.

Those who have professional questions or desire additional information are invited to write Dr. William Karush, Head of the System Development Corporation Operations Research Group at 2414 Colorado Avenue, Santa Monica, California.

"A THEOREM IN CONVEX PROGRAMMING"

A paper by Dr. Karush is available upon request. Address inquiries to Dr. William Karush at System Development Corporation.

SDC

SYSTEM DEVELOPMENT CORPORATION

Santa Monica, California

11-72C

west coast industry

by Fred S. Hunter

North American Aviation keeps making schedule on the *X-15*. The No. 2 vehicle is coming right along and will be ready for delivery shortly. No delays have been encountered in preparations for the first flight of the No. 1 aircraft. The Boeing B-52, modified to airlift the rocket craft under the wing, is at Edwards Air Force Base, flown over from Palmdale, and has been satisfactorily test-flown. Apparently, about the only thing that might cause any setback in the first flight would be water in the lake bed. The dry lake doesn't drain off very fast after a heavy rain.

Big engine—NAA's *X-15* schedule now calls for initial use of interim XLR-11 engines in the No. 2 aircraft, same as in No. 1. This means the first vehicle to make use of the higher-thrust XLR-99, designed for the *X-15* by the Reaction Motors Division of Thiokol Chemical Corp., will be the No. 3 aircraft, due in June. Retrofits of the No. 1 and No. 2 vehicles will follow. Necessity of using the lower-thrust rockets, designed originally by Reaction for the Bell *X-1*, is not expected to hold up the program. The XLR-11 in the eight-chamber rocket package worked out for the *X-15* is double the thrust of the *X-1* configuration, and does very well. It also looks as though everybody is satisfied with the progress being made on the high-thrust XLR-99, now on the test stand. The Rocketdyne backup project, initiated when XLR-99 dropped behind schedule, has been terminated as no longer necessary.

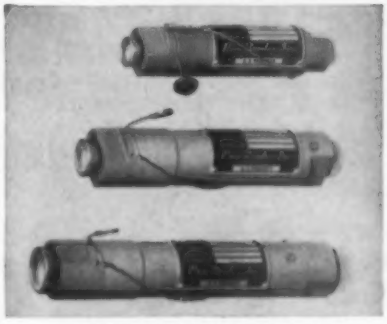
Losers learn—Watch for tighter, better bidding in the future as a result of the de-briefing program the Air Force set up for unsuccessful bidders in the *Minuteman* assembly and test competition. Those who lost out now know exactly why the award went to the Boeing Airplane Co. They also know where their own proposals fell short. So far as we know, this is the first time a military agency has provided the losers in a competition with a detailed picture of the step-by-step evaluation processes used in determining an award. The ballistic missiles groups headed by Maj. Gen. Bernard A. Schriever and Maj. Gen. Ben I. Funk have a good idea that should pay dividends down the road both for the Air Force and for industry.

New fields—Solar Aircraft Corp., which has made more than 4000 *Falcon* fuselages, *Nike* air vanes and some other missile components under subcontract, is submitting proposals for prime contracts on smaller missile systems as part of its program to accelerate its work in the missile field. It also is well into some phases of design and initial production of *Minuteman* solid-fuel rocket cases and accessories under subcontract to Thiokol Chemical Corp. To process rocket-engine assemblies made from new types of air-hardening steel alloys, Solar is installing a special 31x12-foot furnace at its San Diego bayfront leasehold. The maker calls it the world's largest atmosphere-controlled, heat-treat furnace.

Honeycomb progress—Northrop Division of Northrop Aircraft, which becomes the Norair Division of Northrop Corp. when the name change is made effective Feb. 2, represents another example of accelerating for missile and space work. It recently turned out the first large, stainless-steel, honeycomb panel following the installation of two production-brazing machines. "We intend to be ready for any job asked of us," said Manufacturing Vice-President Bob Lloyd. And, in his first management club address since becoming vice-president and general manager of the division, Dick Nolan reported: "We are definitely pointing toward space products. We have fine talent in this field—as good as any in the nation."

Electronics growth—With electronics sales for industrial and commercial use drawing ahead of sales of consumer items in 1958 for the first time, C. B. Thornton, President of Litton Industries, foresees the influence of electronics permeating every area of our economy, "making its presence felt just as electricity has done."

HYDRAULIC RELIEF VALVES
EXCEED PERFORMANCE
OF NEW SPECIFICATION*
FOR TYPE II SYSTEMS



*MIL-V-8813 (ASG)
(Obsoletes MIL-V-5523B)

NEW SPECIFICATION SPECIFIES
- Higher operating temperatures (275°F)
- Lower spread - full flow to reseat

PneuDraulics RELIEF VALVES ARE GUARANTEED TO EXCEED THE SPEC* REQUIREMENTS FOR all 4 pressure classes!

Qualification Test Report Available

Valve Features:
1. No Dynamic O-Rings—No Hysteresis
2. Dash Pot—No Noise or Chatter
3. No Outlet Jet Effect
4. Flow Compensated Operation
5. Light Weight—Low Stress Springs

PneuDraulics, Inc.
1294 East 3rd Street — Pomona, California
NAtional 9-0677

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SIGHTED:

Missiles and Rockets Classified Page

Quick results are yours when you buy, sell, or seek employment through the classified page of MISSILES AND ROCKETS Magazine. Reach 30,000 top missile and rocket men. Send your message today to

MISSILES & ROCKETS
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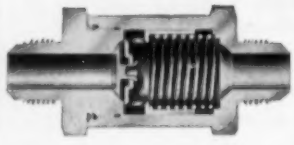
ground support and test equipment

REPUBLIC VALVES

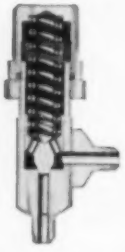


FREE-FLOW CHECK VALVES

No leakage. 3000 psi. Very low pressure drop. Can be furnished to open at ¼ to 35 psi. Brass, stainless steel, or aluminum alloy. ⅛" to 2" pipe or tube. Temp. range -65° to 200°F.

RELIEF VALVES

Quick unloading, smooth operation. Guided shut-off piston with stainless steel or Nylon seat. Pressure range to 4000 psi. Brass, aluminum alloy, or stainless steel. ⅛" to ¾" pipe or tube. Temp. range to 400°F.



HAND PUMP

For hydraulic applications on missile carrier and support equipment. Double-acting. 2 cu. in. displacement per cycle. 1000 psi. working pressure. Aluminum alloy body, stainless steel trim. -65° to 160°F.

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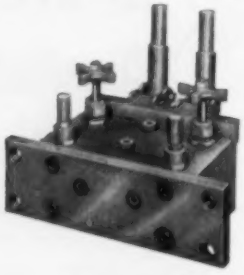

DUAL HAND PUMP

2 pumps, 2 relief valves, and 2 needle shut-off valves, compactly manifolded for elevating mechanisms, hydraulic applications on ground support equipment, etc. Aluminum alloy body, stainless steel trim. -65° to 160°F.

Distributors in principal cities coast to coast

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contract awards

ARMY

$5,866,290—**Firestone Tire & Rubber Co.,** Los Angeles, for *Corporal* system, (part of larger contract of $11,733,840 to be finished by Feb. 13, according to Ordnance Command). Apparently, subcontracts are: $570,000—**North American Aviation, Inc.,** for rocket engines; $236,396—**Topp Mfg. Co.,** Los Angeles, for transducers; $140,588—**Associated Aero Science Lab., Inc.,** Hawthorne, Calif., for technical assistance; $38,235—**Gilfillan Bros., Inc.,** Los Angeles, for repair parts; $34,995—**North American Aviation, Inc.,** for study relating to boundary layer surface material interactions.

$5,866,880—**Raytheon Mfg. Co.,** for engineering services and electronic components for *Hawk*.

$92,672—**Barnes Engineering Co.,** Stamford, Conn., for research in measurement of re-entry bodies of missiles.

$1,887,027—**Northrop Aircraft, Inc., Nortronics Div.,** for a prototype automatic test system for guided missiles.

$1,507,021—**Daniel Construction Co. of Alabama,** Birmingham, for construction of propellant development facilities (Thiokol) at Redstone Arsenal.

$245,296—**Butler & Cobbs,** Montgomery, Ala., for construction of engine development motor test facility at Redstone.

$386,698—**Douglas Aircraft Co., Inc.,** Charlotte, N.C., for *Nike* spare parts and components.

$347,492—**Western Electric Co., Inc.,** New York for *Nike* spare parts and components.

$200,000—**Emerson Electric Mfg. Co.,** St. Louis, for design and development of rocket motor.

$337,544—**The Cardan Co.,** Los Angeles, for missile assembly building at Vandenberg AFB.

$109,482—**Joseph F. Bester,** Riverside, Calif., for additions to building at Jet Propulsion Laboratory, Pasadena.

$41,455—**Michigan Tectronics, Inc.,** Detroit, for cable assemblies and ordnance parts.

$155,821—**National Co., Inc.,** Malden, Mass., for three engineering test models of Type "B" ground cesium atomic beam frequency standard, to be used by ABMA in connection with missile guidance.

AIR FORCE

$8,000,000—**Lockheed Missile Systems Div.,** Van Nuys, for continued testing of research vehicles in support of *Bomarc* program.

$1,600,000—**Northrop Aircraft Inc.,** Nortronics Div., for design and manufacture of a *Snark* proficiency trainer.

$932,870—**Yardney Electric Corp.,** New York, for *Bomarc* batteries (A Boeing subcontract.)

$700,175—**Boeing Airplane Co.,** Pilotless Aircraft Div., for technical data for *Bomarc* components (nine contracts); $135,975 for logistic depot in support of *Bomarc*.

$64,419—**Radiation Inc.,** Melbourne, Fla., for data transmission interconnection links.

$110,000—**Douglas Aircraft Co.,** Santa Monica, for engineering data, modification kits and spare parts for *Genie* rocket.

$40,264—**Graphic Films Corp.,** Hollywood, for production of color, sound film entitled "Astronautics."

NAVY

$2,000,000—**Collins Radio Co.,** Cedar Rapids, Iowa, for a high-density microwave system at the Pacific Missile Range.

$1,300,000—**Allen B. Du Mont Laboratories, Inc.,** for *Sparrow III* missile test sets. (Raytheon subcontract.)

$923,883—**Dale Benz, Inc.,** San Diego, **L. F. Stilwell & Co.,** Los Angeles, and **Cox Bros. Construction,** Stanton, Calif., separate contracts for construction at Naval Missile Test Facility, Point Arguello, Calif.

$648,015—**Wells Benz, Inc.,** San Diego, for construction of launch complex No. 1 at Naval Missile Test Facility Point Arguello.

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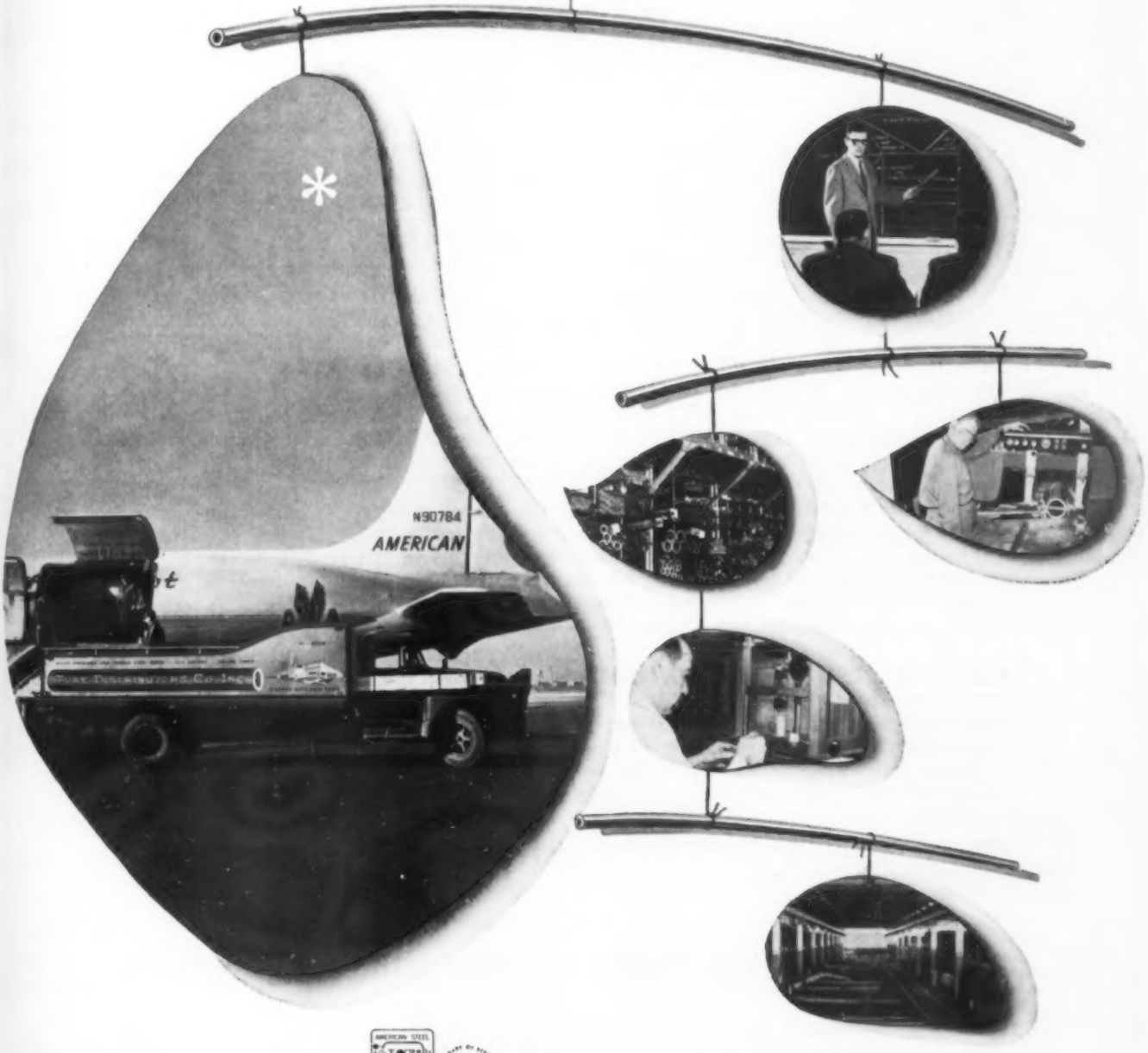

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missile people

John J. Crowley, former director of the Guided Missile Office of the Assistant Secretary of Defense for Engineering has been named vice president of the Grand Central Rocket Co. and will assume charge of project management. Crowley resigned from General Dynamics Corp. where he had been an executive assistant to the senior vice president for engineering.

Vice Admiral Charles B. Momsen (ret.) recently was named engineering consultant for the Bendix Aviation Corp. Adm. Momsen, known for his work on the "Momsen Lung"—a submarine escape device—will work on top-priority research and development programs.

Joseph E. Long, formerly Aerodynamic Research Supervisor, Navy Bureau of Ordnance, is now Aeronautical Research Engineer, Mechanics Division, Directorate of Aeronautical Sciences, Air Force Office of Scientific Research.

Cmdr. George Hoover, one of the country's early space flight exponents and prime mover of Project *Orbiter*, predecessor of the *Explorer* satellite, has left the Navy after 25 years to become director of technical planning for Benson-Lehner Corp., manufacturers of data processing machines. Hoover will have responsibility for 10-years-ahead technical development planning.

These appointments have been announced recently:

Garrison Norton, former Assistant Secretary of the Navy, as president of Institute for Defense Analyses.

Max Lehrer, specialist on Defense Department budgets, as assistant staff director of the Senate Committee on Aeronautical and Space Sciences.

J. R. Juncker as military relations engineer for the Semiconductor-Components division of Texas Instruments Inc.

Chance Vought Aircraft, Inc. has announced election of **Gifford K. Johnson** to the presidency of Genesys Corp., its new commercial electronics subsidiary in Los Angeles.

Vincent Prus is in charge of Goodyear Aircraft Corp.'s *Subroc* underwater guided missile production program.

Frank B. Jewett, Jr., has been elected executive vice president of Vitro Corp. of America, and **William B. Hall** was made a vice president of the corporation.

Carl G. Holschuh, executive vice president of Sperry Rand Corp. has accepted a one-year appointment to the governing Council of AOA.

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West Coast: 8929 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr.; James W. Claar, regional adv. mgr. Phones: OLeander 5-9161 or OLympia 7-1555.

Chicago: 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

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Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: Harbour 6898. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

Geneva: American Aviation Pubs., 10 Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director. Cable address: AMERAV GENEVA.

London: Norall & Hart Ltd., 28 Bruton Street, London W. I., England. Phone: Grosvenor 8356.

Paris: Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine, 15-39, Cable address: NEWS AIR PARIS.

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Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Jan. 28-29.

Columbia University and Sylvania-Corning Nuclear Corporation, First International Symposium on Nuclear Fuel Elements, Columbia University, New York, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 12-13.